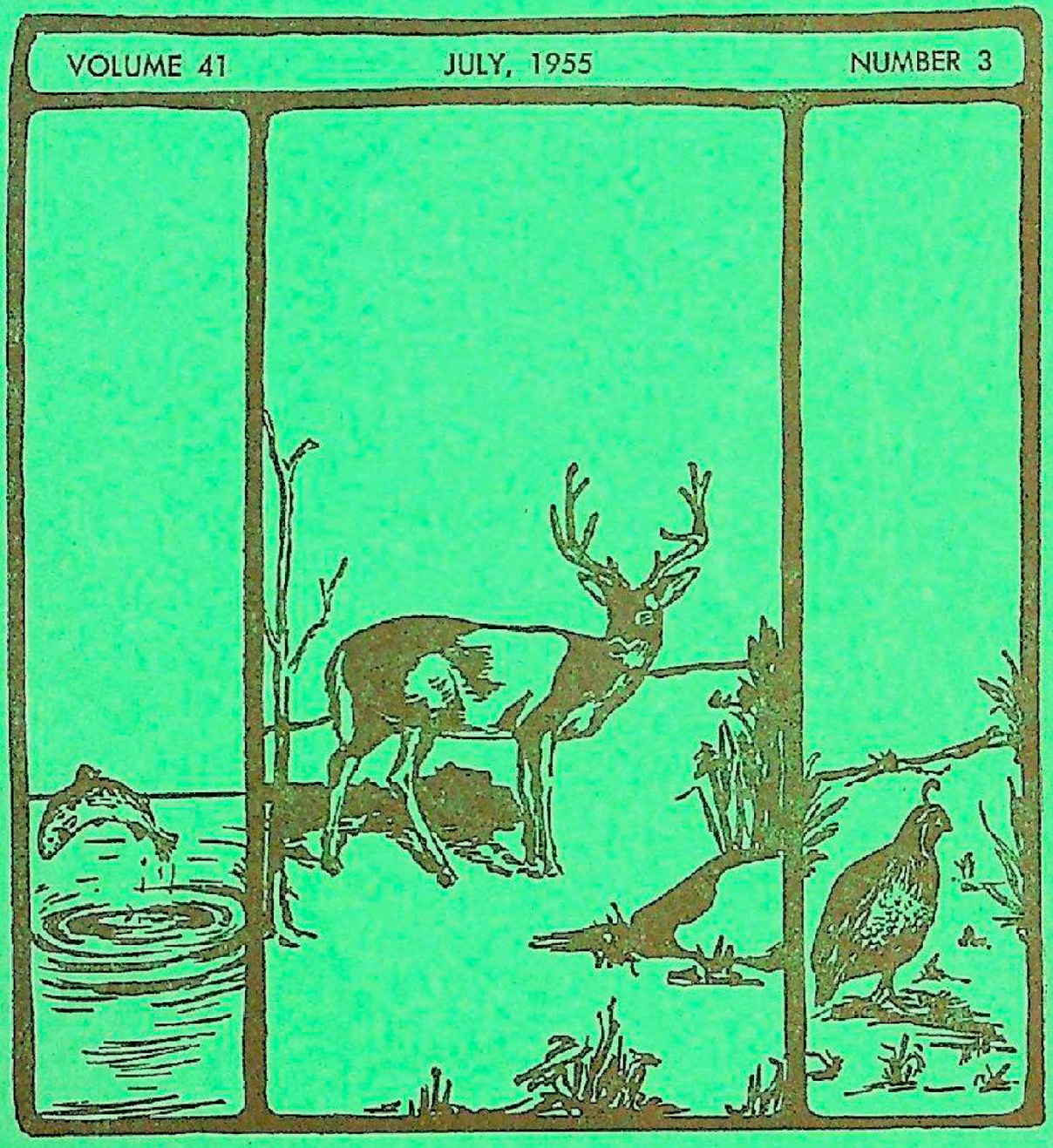
CALIFORNIA FISH AND GAME

"CONSERVATION OF WILDLIFE THROUGH EDUCATION"

VOLUME 41 JULY, 1955 NUMBER 3



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CALIFORNIA FISH AND GAME

VOLUME 41 JULY, 1955 NUMBER 3

Published Quarterly by the
CALIFORNIA DEPARTMENT OF FISH AND GAME
SACRAMENTO

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OBSERVATIONS ON THE FEEDING HABITS OF THE OPALEYE, *GIRELLA NIGRICANS*[1]

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Chicago, Illinois

The opaleye, *Girella nigricans* (Ayres), is a familiar fish to skin divers and sportfishermen in the Los Angeles region. The young are conspicuous in the tide pools and surf zone of rocky shore areas, and the adults abound in large schools in the offshore kelp beds. Although it is not highly regarded as a food or game fish, the species is taken in large numbers by anglers and especially by spearfishermen.

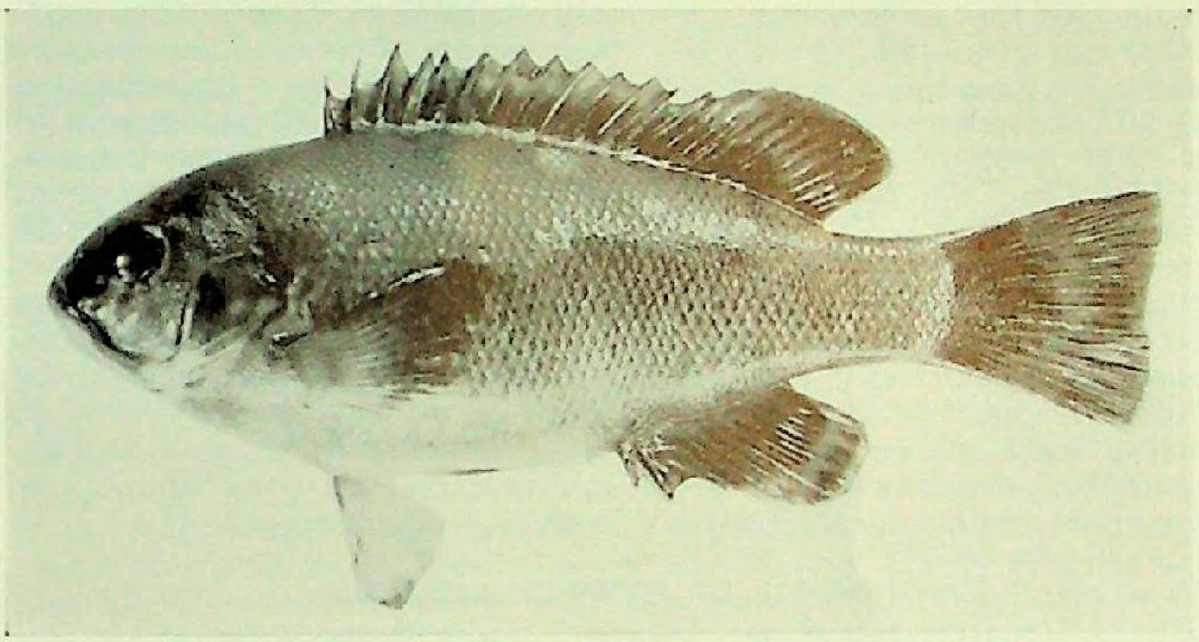

FIGURE 1. The Opaleye, *Girella nigricans* (Ayres).

There are number of references to the diet of the opaleye. Jordan and Fesler (1893) state that the animal is herbivorous. Metz (1912) investigated a series of specimens from Laguna Beach and reported, "Specimens dissected contained only pieces of kelp, red algae, etc." Popular writers and later faunal works have restated these observations, but no new data were reported until recently (Mitchell, 1953). Mitchell concluded that the opaleye is herbivorous when above 70 mm. standard length, carnivorous below 50 mm., and of mixed diet between these sizes. The conclusions expressed in the present paper differ considerably from Mitchell's.

[1] Submitted for publication October, 1954.

In his popular book on West Coast angling, Cannon (1953) offered special instructions for the opaleye angler, with both plant and animal baits recommended. Chopped mussel seems to be especially attractive to the opaleye.

MATERIALS AND METHODS

Stomach contents of 247 fish were examined. These specimens were taken in 31 low tide collections, using rotenone and dip nets. One collection was taken at Corona del Mar in Orange County and the others in Los Angeles County between Redondo Beach and San Pedro. All stomachs were examined in the case of collections containing only a few fish. Subsamples from the larger collections were selected to include fish from the entire size range.

Stomach contents of each fish were placed in a watch glass and examined under a dissecting microscope. The standard length of each fish was taken and a record made of whether plant or animal matter was present in greater volume in the stomach. The decision as to relative volume was subjective and usually made in a matter of seconds, but it is thought that no increase in accuracy would have resulted from more laborious techniques. Usually the diagnosis was obvious, either plant or animal matter being clearly preponderant. Ordinarily a magnification of 20X or less was sufficient to permit classification of the contents of a stomach. Most algal tissues were obviously cellular at such magnifications, and the presence or absence of distinct cell walls was an important key character for small amorphous fragments. Animals were usually whole organisms and therefore easily recognized. Most of the stomachs were well filled, but a few contained only an amorphous mucous material and a few fragments, which in most instances, however, were sufficiently recognizable to determine whether or not the food was primarily vegetable or animal. Stomachs were classified as empty only when nothing recognizable was found. Because of this, several of the stomachs of larger fish tabulated as containing a predominance of animal matter were in reality nearly empty.

RESULTS OF STOMACH ANALYSIS

A considerable and significant difference in diet was found between small fish (under 33 mm.) and larger fish. Apparently there is a change from a mixed animal-vegetable diet to one primarily herbivorous. This change appears to be largely complete by the time the fish have reached a length of 32 mm., and no further changes could be demonstrated (Figure 2). The first size group, 23 to 32 mm., represents the extreme range of the young which are newly recruited in the tidepools and still bear traces of the silvery coloration of the pelagic postlarvae. Many older fish which had already lost their silvery color measured less than 32 mm. but were included in this first group. Since even these smallest tide pool residents had more plant than animal matter in their stomachs, it is quite unlikely that there is any predominantly carnivorous stage among the opaleyes in rocky shore areas, as was concluded by Mitchell (1953). Field observations, reported below, of feeding activity in tide pools also indicate a largely herbivorous diet for even the smallest fish.

We believe that the differences between our findings and those of Mitchell may be attributed to his having used but a single collection.

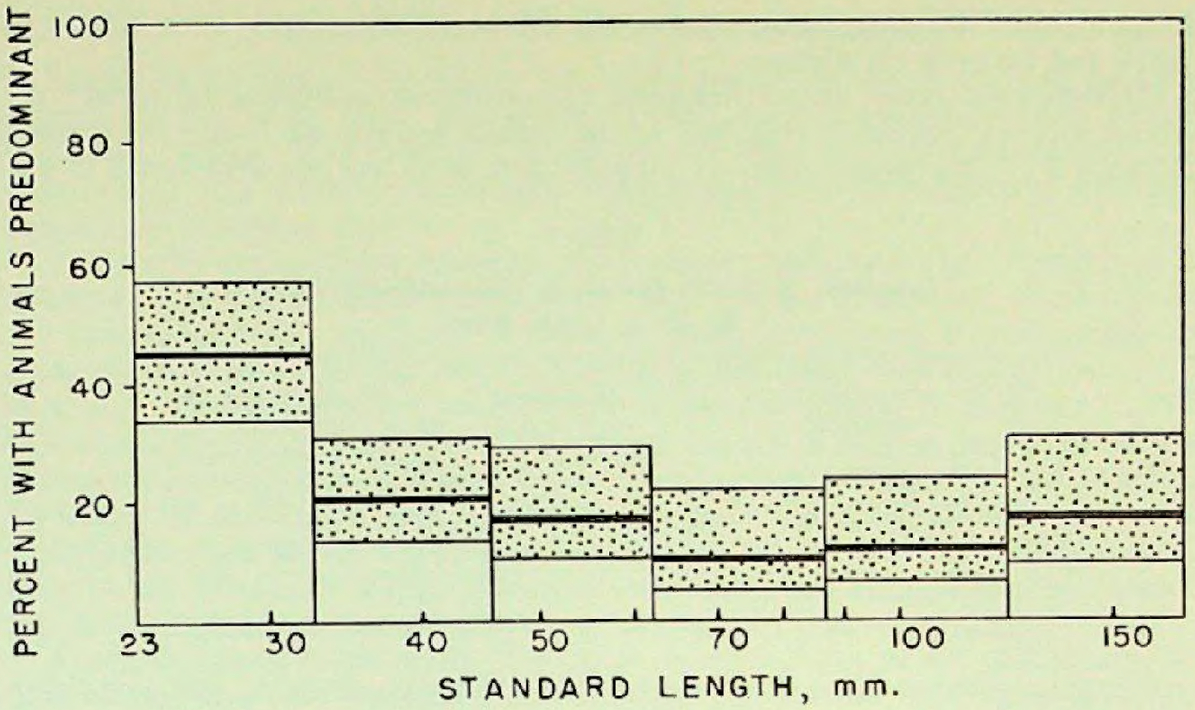

FIGURE 2. Relationship of stomach contents to size in *Girella nigricans*. The heavy horizontal lines indicate observed proportions of fish with more animal than plant matter in their stomachs. Ninety percent confidence limits of these proportions are indicated by the stippled areas. The non-overlap of the confidence limits of the first two proportions indicates that the probability of the difference being due to chance is less than 0.0025. The six samples vary from 31 to 54 specimens and total 237. Ten fish with empty stomachs are not included.[2]

He states that he recorded the "relative bulk" of animal and plant material for the collection as a whole, rather than for individual fish, as in the present study. His figures, given in round numbers (40 percent, 50 percent, etc.), indicate that he relied, as we have done, on visual estimates. In order to have some data directly comparable with those of Mitchell, the stomach contents from four of our larger collections comprising fish less than 50 mm. standard length were combined. According to Mitchell fish of this size should be primarily carnivorous. One of our collections did in fact show more animal than plant material in the individual fish as well as in the combined sample. The other three collections, however, provided no more than a trace of animal matter in the stomachs. Our collections obviously show considerable variation, and Mitchell's one collection might well have been extreme.

The fish investigated in this study were juveniles and subadults, as indicated by gonad examination. It is generally believed that the adult opaleye is herbivorous, but we have no quantitative data for fish larger than 173 mm. We have cleaned larger fish, however, and noted the presence of algal matter in the stomachs and intestines. Some specimens

[2] Some further explanation of the unusual graphic procedure may be in order. The size groups include equal proportionate ranges and are plotted on a logarithmic scale. The advantages of this system over conventional histogrammic presentation are: the provision of finer distinctions in the smaller size ranges, in which important changes occur; the provision of larger sample sizes for the larger fish; and the magnification of that part of the diagram, that dealing with the smaller sizes, which is of greatest interest. It was convenient to include in the first group all those fish which bore traces of the silvery coloration characteristic of the pelagic postlarval stage. These silvery fish vary from 23 to 32 mm. Since 32 is about 1.4 of 23, the factor 1.4 was chosen to define all of the size groups to be plotted. The first six groups so defined include all but two of the fish examined.

longer than 200 mm. were opened by Metz (1912), and were found to have fed largely on algae.

Differences were noted between the stomach contents of newly arrived silvery recruits and fish of the same length of longer residence (Table 1). The proportion of silvery fish with empty stomachs is sig-

TABLE 1

Comparison of Stomach Contents of Silvery and Dark Fish in the 23- to 32-mm. Group

Stomach contents	Number of silvery fish	Number of darker fish
Empty	5	1
Mostly plant	1	23
Mostly animal	3	17

nificantly greater than that of the dark fish ($p=<.01$), but no difference could be demonstrated in the proportion of ingested vegetable and animal matter. The opaleye is thought to be carnivorous in the pelagic larval stage, and perhaps the young newly arrived in the tide pools are not immediately able to exploit the food resources there.

Seasonal bias is present for these smaller fish, since near Los Angeles they are numerous only in the summer and early fall. Every season of the year is abundantly represented in our collections by fish larger than 32 mm. On the other hand, samples of the larger fish were biased with respect to habitat. The larger individuals normally occur offshore in water many meters in depth, but our collections were all made in the shallow inshore waters. Our conclusions, therefore, can apply only to the shallow-water representatives of the species.

In those stomachs containing a preponderance of algae the animal material was frequently in the form of sessile growths, minute mollusks, ostracods, and other forms which might have been incidentally ingested with the algae. Larger, more active animals were sometimes found in stomachs containing more animal than plant matter. The kinds of such animals varied greatly from one collection to another. One group of four specimens (39 to 128 mm.) in a collection of 11 fish had been feeding almost entirely on the larvae and pupae of a fly, identified by Dr. John N. Belkin of the University of California as an undescribed species of *Coelopa*. These flies, the only abundant animals in the stomachs of this collection, were not observed in any other sample.

In another collection four out of six specimens which had appreciable amounts of animal matter in their stomachs had been feeding largely on minute eggs of an unidentified invertebrate. Amphipods and small decapod crustaceans were common in a few of the collections.

The ingested algae were found to vary according to the size of the fish. The smallest fish had fed largely on fine filamentous growths and other delicate matter. Diatoms were observed frequently in the stomachs. Large fish had eaten sizable pieces of red, brown, and green algae, as well as large amounts of finer material.

EVALUATION OF STOMACH ANALYSIS

Stomach contents, especially of herbivorous fishes, may not always accurately indicate diet. Marshall (1946) found evidence that plant material (algae) was retained much longer than animal material in the stomach of the minnow, *Notropis chalybaeus*, thus erroneously indicating an herbivorous diet.

A simple experiment showed that algae pass rapidly through the opaleye. Seventeen of 21 fish (35-96 mm.) were preserved in the field for future stomach analysis. Sixteen of these contained a predominance of algae and one had an empty stomach. The four remaining fish (41-88 mm.) were taken alive and held in an aquarium at 15 degrees C. At the time of collection, these fish presumably had the same stomach content composition as those which were preserved in the field. After 15 hours of captivity their alimentary tracts were dissected and found to contain food material, consisting almost entirely of algal fragments, only in the posterior parts of the intestines. It appears, then, that algae are not retained in the stomachs for any great length of time.

Another experiment with *Girella* indicated little or no difference in rate of elimination for materials of varying texture and digestibility. A mixture of duckweed and finely chopped stained shrimp was fed to six fish (43-69 mm.), which were dissected after 18 hours at 15 degrees C. Four had completely eliminated the food mixture, but two had both shrimp and duckweed in the intestine, with no apparent stratification. It is likely, then, that the proportions of materials found in the stomachs of the opaleye closely approach the proportions actually ingested, although certain possible sources of error, such as differential regurgitation of plants and animals induced by rotenone, have not been considered.

Herbivorous fishes present physiological problems which have never been carefully investigated. Ingested algae invariably support microfaunas which undoubtedly contribute to the nutrition of the fish. There may be fishes with little or no ability to utilize plant tissues, but which pass algae through the gut in such quantities that the associated animal matter might be sufficient to provide all needed nourishment. Such fishes might actually select the algae with the richest faunas. Then, again, fishes may derive some benefit from ingested vegetation itself, even though the bulk of it passes through undigested.

None of the various algae which pass through the gut of *Girella* appears to be greatly altered physically. The fragments are often slightly smaller and somewhat discolored by the time they reach the anus, but peristaltic action and the absence of light may be solely responsible for these changes.

FIELD OBSERVATIONS

On rocky shores at low tide it is easy to observe small specimens of *Girella*, up to perhaps 50 mm., in the tide pools. They seek cover when approached, but if the observer is patient and remains still, the fish shortly reappear and begin feeding. Much of their time is spent nibbling or grazing on submerged rocks and vegetation. They become more wary with increasing size, and 100-mm. fish are very difficult to observe.

At high tide the opaleye can be observed in the surf zone with the aid of a diving mask. Turbulence is generally of sufficient strength to keep the fish constantly moving and precludes any prolonged grazing. The fish move about in schools and are seldom observed feeding on the bottom, as is their habit at low tide. Occasionally at high tide we have observed them darting short distances, as if "striking" at some small swimming or floating object.

These observations suggest that most animal matter is consumed at high tide, and most algae at low. The presence of large numbers of fly larvae in the fish stomachs of one collection supports this interpretation. These insects apparently breed in the piles of decaying seaweed left near the high water line and, therefore, may be accessible to the fish only at high tide.

ACKNOWLEDGMENT

We wish to thank Dr. Boyd W. Walker of the University of California at Los Angeles for providing working facilities, the loan of study material, and valuable advice given during the investigations and the preparation of the manuscript.

SUMMARY

The newly recruited, 23- to 32-mm. young of *Girella nigricans*, which are abundant in the summer in tide pools near Los Angeles, have a mixed plant-animal diet. About 55 percent of the individuals in this size group have more plant than animal matter in their stomachs. Larger fish are primarily herbivorous, about 85 percent having a preponderance of plant material in their stomachs.

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RESULTS OF THE 1954 PISMO CLAM CENSUS[1]

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During the 1954 Pismo clam census, conducted by members of the Marine Fisheries Branch at Pismo Beach and Morro Bay December 8th to 11th, the regular sections, Le Grande, Oceano, Pismo, and Morro, were sampled (Fitch, 1952).

This census yielded good returns of older clams in the sanctuaries at both Pismo Beach and Morro Bay. Digging outside these closed areas was extremely poor for both old and young clams. A six-inch wide strip in the Morro Bay sanctuary, dug from the highwater mark seaward as far as possible, yielded 32 clams. Of these, 15 had attained legal size, 23 were older than eight years, and only two were less than 24 months of age (Table 1).

TABLE 1

Number of Clams by Age Group Taken in the Morro Section in 1954

Section	Age group									Total
	0	I	II	III	IV	V	VI	VII	VIII+	
Morro	2	0	6	0	0	0	1	0	23	32

Three similar strips dug on Pismo Beach yielded 163 clams: 131 from the present sanctuary (Oceano); 31 from the area directly in front of the town of Pismo Beach (Pismo); and only one from the former closed area (Le Grande) (Table 2). Fifty of the 131 clams dug

TABLE 2

Number of Clams by Age Group Taken in the Three Pismo Beach Sections in 1954

Section	Age group									Total
	0	I	II	III	IV	V	VI	VII	VIII+	
Oceano	1	0	20	5	0	0	8	10	87	131
Pismo	2	1	20	3	0	0	0	1	4	31
Le Grande	0	0	0	0	0	0	0	0	1	1
Total	3	1	40	8	0	0	8	11	92	163

[1] Submitted for publication February, 1955.

from the present sanctuary had attained legal size. Of the 131, 105 were age six or older and of the remaining 26 only one was of the current year's hatch.

Only one (10 years of age) of the 31 clams dug in front of Pismo Beach was of legal size. Twenty-six were younger than four years and the remaining four ranged from 7 to 11. The single clam from the former closed area, though aged at nine years, had not yet attained legal size.

From this and previous censuses it is obvious that clam recruitment at Pismo Beach has been extremely poor since 1947, while at Morro Bay no worthwhile sets have occurred since 1944. Table 3 details the number of age zero clams that have been taken from each of the three sections at Pismo Beach since 1925. During the war years, and for some of the sections in 1948 and 1950, censuses were not made because of manpower shortages. From the number of older clams in postwar censusing (Fitch, 1952) it appears evident that during all four years, 1942 through 1945, there were exceptionally good sets of clams. It will be noted from Table 3 that there have been two previous periods of poor recruitment, namely: 1925 through 1928 and 1938 through 1941. Herrington (1930) indicates that both 1919 and 1924 were years of well above average recruitment and in view of this it may be inferred that the present "drouth" (eight years) has lasted twice as long as

TABLE 3

Number of Clams, Age Group Zero, Taken During Regular Censuses From 1925 to 1954

	Le Grande section	Oceano section	Pismo section	Totals
1925	18	5	0	23
1926	4	3	46	53
1927	3	20	15	38
1928	0	0	6	6
1929	106	155	214	475
1930	40	79	241	360
1931	174	403	308	885
1932	13	14	17	44
1933	7	151	41	199
1934	0	1	0	1
1935	151	194	425	770
1936	0	83	61	144
1937	98	166	483	747
1938	0	5	4	9
1939	0	19	5	24
1940	0	17	8	25
1941	2	11	6	19
1942	—	—	—	—
1943	—	—	—	—
1944	—	—	—	—
1945	—	—	—	—
1946	167	329	111	607
1947	10	16	6	32
1948	—	0	—	0
1949	1	0	0	1
1950	0	0	—	0
1951	0	0	0	0
1952	1	8	19	28
1953	0	0	0	0
1954	0	1	2	3
Totals	795	1,680	2,018	4,493

any similar period since 1924. Table 3 indicates that there can be extended periods of good setting as well as poor. The best sets seem to occur on the north end of the beach (Pismo section).

CONCLUSIONS

The outlook for clam digging at both Pismo Beach and Morro Bay in the immediate future is rather dim. Even should the 1955 census reveal an exceptional number of claims of the year at these beaches, a considerable period of time would elapse before these clams would be five inches in length (legal size). Biological investigations at Pismo Beach indicate that the clams require at least five years to grow to five inches and that most of them need seven or eight years to reach this size. Similar studies at Morro Bay indicate an even longer growing period there; eight or nine years are required for most Pismo clams to reach legal size. From these figures it can readily be observed that a good set of clams at Pismo Beach in 1955 would not provide really good digging until 1962 or 1963. At Morro Bay good digging would not result until 1964 or later.

It should be understood, however, that there are no assurances of a good set of clams at either of these beaches in 1955—or in any succeeding year, for that matter. On the other hand, there is every reason to believe that good digging for the clams currently on these beaches (1947 year class and older at Pismo Beach and 1944 year class and older at Morro Bay) will not continue much beyond 1958. From these data it can be concluded that successful clamming at Pismo Beach and Morro Bay will decline for a period of several years and in the not far distant future will be considerably below average.

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MULTIPLE CAUDAL SPINES IN THE ROUND STINGRAY, *UROBATIS HALLERI*[1]

FINDLAY E. RUSSELL[2]
From the William G. Kerckhoff Laboratories of the Biological Sciences, California Institute of Technology, Pasadena

Multiple stings or caudal spines in the stingrays have been observed by many investigators, though their relative incidence and significance is not known. The present study was initiated to determine the frequency of multiple stings in the common round stingray, *Urobatis halleri*. A study was also made of certain correlations between the length of this fish and its several caudal spines.

Belon (1553) was perhaps one of the earliest of writers to examine and record the occurrence of multiple caudal spines in the stingrays. Writing of the ray, "*Pastinaca marina,*" Belon notes: "the spine is as long as a man's finger and is sometimes double and sometimes triple." Gesner (1558), a contemporary of Belon, published drawings of two stingray tails each showing two spines. According to Gudger (1944), these are among the earliest of illustrations showing multiple spines. In his review of the spotted eagleray, *Actobatus narinari*, Gudger (1914) lists spine counts for 24 specimens, of which four had a single spine, nine had two spines, four had three, five had four, and two had five. More recently Halstead and Modglin (1950) have examined a number of specimens of *Holorhinus californicus* and found the number of stings to vary between one and three.

During the 24-month period October, 1951, to October, 1953, a total of 1,316 specimens of the family Dasyatidae were collected from the bays, sloughs, and beaches along the southern California coast. Of these, 1,196 were round stingrays; however, this should not be interpreted to imply that the round stingray is that much more abundant in the waters off southern California than the other two dasyatids known to occur there. While it is generally presumed that this species is the most common in that locale, the particular net used in the seining operations was designed for the taking of this species, which seldom swims very far off the bottom, thus perhaps limiting its usefulness in the seining of the other members of the family, which on occasion swim near the surface of the water.

Each fish was classified as to length, number and size of stings, and sex. The caudal spines, along with that portion of the tail proximal to the stings, were severed and processed for other studies. The fish were then returned to the ocean.

The mortality from this operation was probably very low. Of 50 such fish observed for a three-week period in the tanks of the Kerckhoff

[1] Submitted for publication September, 1954.
[2] Bank of America-Giannini Fellow, 1952-53. Present address: Institute of Medical Research, Huntington Memorial Hospital, Pasadena.

TABLE 1

Months and Localities From Which Round Stingrays Were Taken

Locality	Number of specimens												
	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Totals
Santa Monica	0*	2*	2	3*	4	11	**	**	16	14	**	5	57
Long Beach	2	6*	4*	8	10	19	26	30	47	36	**	8	196
Alamitos Bay	4	4*	8	10	**	34	47	80	178	87	30	16	498
Balboa Bay	4*	5	6	10	16*	30	34*	60	91	71	15	7	349
Oceanside	1*	4*	3*	7	6	6	14	18	13*	12	7	5	96
Totals	11	21	23	38	36	100	121	188	345	220	52	41	1,196

* Five sets once a month. ** No sets.

Marine Station at Corona del Mar, only 4 percent died. The mortality rate for 50 control specimens was 2 percent. The amputations were performed in such a manner that fish taken from a particular area for a certain month could be identified if caught at a later date. Most of the rays were taken with a beach seine; a few were speared or caught with hook and line.

Table 1 indicates the months and localities from which the 1,196 round stingrays were taken. An attempt was made to complete five sets at each designated area twice a month.

Table 2 indicates the correlation of the length of the stingray with the length of the primary sting. The correlation coefficient for the relationship between the length of the primary sting and the presence of a

TABLE 2

Correlation of Length of Stingray to Length of Primary Sting

Length of stingray in cm.	Length of primary sting in cm.					
	1–1.99	2–2.99	3–3.99	4–4.99	5–5.99	Totals
10–14.99	13	4	----	----	----	17
15–19.99	5	36	6	----	----	47
20–24.99	12	58	140	22	----	232
25–29.99	----	27	111	255	2	395
30–34.99	----	9	46	269	12	336
35–39.99	----	2	11	70	9	92
40–44.99	----	----	3	59	15	77
Totals	30	136	317	675	38	1,196

Product moment $r = 0.64$. $\sigma = 0.017$.

secondary sting is considerably smaller, as demonstrated in Table 3. There is a slightly greater tendency for those fish with larger primary stings to possess secondary stings, although this correlation is exceedingly small ($\phi = 0.153$). This incidence might be considered as a rate 2.5 percent greater than chance.

TABLE 3

Correlation of Length of Primary Sting to Presence and Absence of Secondary Sting

Median length of primary stings 4.1 cm.	Secondary stings	
	Present	Absent
Length of primary sting > 4.1	332	266
Length of primary sting < 4.1	242	356

* $\phi = 0.153$ 28 $p < 0.01$

* Phi coefficient calculated as described by Guilford (1950).

The largest round stingray caught was a female 45.72 cm. in length. This fish was taken on a setline in 100 feet of water off Huntington Beach. It was considerably smaller than the maximum length of the species as recorded by Roedel (1953). This fish possessed two stings, a primary one of 5.9 cm., and a secondary sting of 2.8 cm. The smallest specimen, 12.9 cm., possessed one sting of 1.6 cm. The mean length of the 1,196 fish was 29.0 cm. The mean length of the primary stings was 3.9 cm. Five hundred and seventy-four fish possessed a secondary caudal spine. Of these, four also bore a tertiary spine. The mean length of the secondary spines was 1.1 cm., and of the tertiary spines, 1.2 cm. In one fish, a 20.52 cm. female, the secondary spine was 0.1 mm. longer than its primary spine. There was no evidence of injury or abnormality of the caudal structures of this ray. The ratio of males to females was 2.4 : 1.

The migratory patterns or seasonal movements of the round stingray are not known. While these fish may be observed in large numbers during the summer and fall months in the bays and sloughs, their whereabouts during the colder months has not been demonstrated. As seen in Table 1, they may inhabit the bays in small numbers during the winter months. Seining in the surf during these months usually produces few rays. Some may be taken on setlines at 50-100 feet between the months of December and April. The rays taken at this depth are as a group considerably larger than those observed in the bays. It was noted, however, that these fish tended to return in the summer to the same general areas from which they had been taken the previous year. Of the 482 specimens taken in 1952, 61 were retaken 4 to 14 months later. Thirty-two of these fish were caught in the same bay from which they had previously been seined, 18 were caught less than 15 miles from their original point of capture, and only 10 were retaken at a distance greater than 15 miles from their first capture point.

SUMMARY

1. A study was made of the incidence and certain correlations of the caudal spines of the round stingray, *Urobatis halleri*.
2. Of 1,196 specimens collected, 574 possessed secondary stings; four of these bore three stings. The ratio of males to females was 2.4 : 1.
3. There is a very substantial correlation between the length of the round stingray and the length of its primary sting ($r = 0.64$, $\sigma = 0.017$).
4. There is a slightly greater tendency for the larger stingrays to possess secondary stings than there is for the smaller rays.
5. There is also a tendency for those fish with larger primary stings to possess secondary stings, although this correlation is exceedingly small ($\phi = 0.153$, 28 $p < 0.01$).

ACKNOWLEDGMENT

The author is indebted to Dr. John Stamm for his technical advice.

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THE MALE FLAPJACK DEVILFISH[1]

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Five years ago it was my privilege to publish a notice of the first reported Californian occurrence of one of those extraordinary cephalopods, the so-called flapjack devilfishes, belonging to the genus *Opisthoteuthis* of Verrill. As the species was one not previously known it was duly described and named *Opisthoteuthis californiana* Berry (1949, p. 23). The account was based upon two mature females submitted to me by the Natural History Museum of Stanford University. They had originally been taken by the trawler ANDREW JACKSON in 188 fathoms, off Eureka Bar, in April, 1948.[2] Additional data, together with illustrations of both specimens, were subsequently published (Berry, 1952).

As is commonly the case with cephalopods when a new species must be founded upon females alone, the characters relied upon for specific discrimination, while sound, were not very impressive and I consequently called attention to the urgent importance of the recovery of a male, since that type of animal, through the highly specialized development of its secondary sexual characters, is likely to show a much more conspicuous degree of differential speciation than is the female. Furthermore, very little has hitherto been known of the male of any species of *Opisthoteuthis* with the exception of the well-studied *O. depressa* Ijima and Ikeda of Japan.

It is therefore with profound satisfaction that I am now able to report the capture of an adult male of *O. californiana*. This was taken in 280 fathoms, off Humboldt County, California, by Skipper Virgil Strong and crew of the commercial trawler ALOMA, September 6, 1951. It was turned over to Mr. R. B. McCormick of the California Department of Fish and Game, who in turn passed it on to Mr. John E. Fitch of the Department, from whom I received it. The specimen [S.S.B. 1032] was unfortunately considerably mauled and torn in the trawl, but it is in quite good enough shape to show well the more important characters, and these prove by no means disappointing.

As was anticipated, it is in the sucker-armature of the arms that the principal outward differences from the female are revealed. In the female all the suckers are small; they are almost completely immersed in the surrounding tissue, and are flanked on either side by a series of alternating cirri. In the male a single small sucker lies at the base of each arm near the mouth, around which aperture the eight such suckers form a ring, as in the female. The next succeeding sucker on each arm is similar, but somewhat larger. Then follow 8 to 10 enormously en-

[1] Submitted for publication August, 1954.
[2] Flapjack devilfish may be termed an "occasional" item in the trawler net catches off Eureka. The frequency of occurrence is in direct ratio to the number of deepwater tows made by the trawlers.

larged, closely placed, protuberant, globular, firm-tissued suckers with rather narrow circular openings, which, as is shown in the photographs (Figures 1-2), constitute the most imposing single feature of the animal. On the 6 posteriormost arms these large suckers tend to diminish quite regularly and steadily distad, after having attained a maximum not far above the base of the arm. Then follow a variable number of much smaller suckers, running from about five on each arm of the second pair to 12 on each of the ventrals and 14 on the third arms, after which there succeed some 20 to 30 exceedingly minute suckers continuing to the tips of the arms.

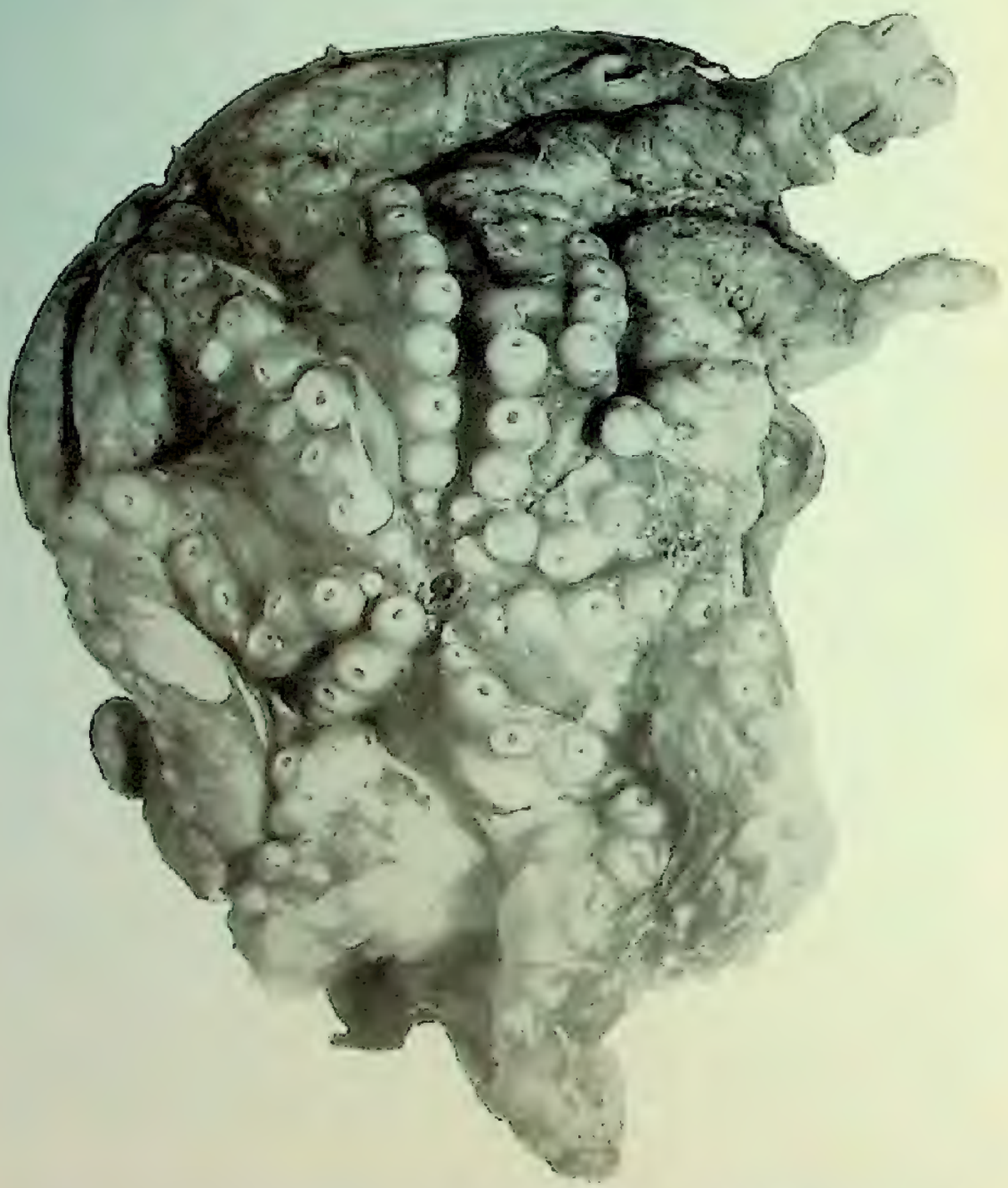

FIGURE 1. *Opisthoteuthis californiana* Berry. Oral aspect of adult male [1032]; x ca. ⅔.

FIGURE 2. *Opisthoteuthis californiana* Berry. Oral aspect of basal portion of right dorsal and second arms, showing giant suckers of male [1032]; x 1½.

On the dorsal arm-pair the state of affairs is quite different, and since these arms are the most highly specialized of the eight, they are apparently, and in equal measure, the ones to be regarded as the "hectocotylized" or nuptial arms. On the basal portions of these the armature is not greatly dissimilar to what I have described for the other six. One or two minute adoral suckers are succeeded by a single somewhat enlarged sucker and this in turn by eight enormously enlarged, closely packed, globular suckers with narrow openings, then another not so enlarged, and then some 11 to 13 small ones again. However, at this quite distal point on the arm there occurs abruptly an enlarged sucker once more, followed by about six suckers of the immensely enlarged spherical type, greatly distorting this part of the arm, and with the openings much constricted and those of the two largest squeezed to little more than simple or slightly crescentic slits (Figure 3). The series finally

FIGURE 3. *Opisthoteuthis californiana* Berry. Oral aspect of distal portion of dorsal arms of male [1032], showing hectocotylization; x ca. 1⅛.

terminates with 10 or 12 very tiny suckers occupying the suddenly reduced and attenuate tip.

The Japanese species, *O. depressa,* is described as possessing so many of the giant suckers on the body of the arms (none of which latter is especially differentiated) that they are crowded into a simulated biserial or even triserial alignment, and there is no separate distal group. Furthermore, the area of small suckers surrounding the mouth is considerably wider, as portrayed in Sasaki's excellent figure (1929, p. 11, figure 4). Indeed I have found no illustration of a male *Opisthoteuthis* or any other octopod which suggests any modification at all comparable to the strange group of giant suckers found on the distal segments of the dorsal arms of the male *O. californiana,* but an hitherto little noticed paragraph in Chun's Michael Sars report,[3] respecting two supposed males of the North Atlantic *O. agassizii* Verrill, assumes increased significance in the light of the present material and is obviously descriptive of a closely parallel specialization. Comparison in detail of course reveals manifest differences, but in the main at least these are doubtless merely specific.

It is also to be noted that the male *O. californiana* differs from the female not only in the peculiarly modified enlargement of so many of the suckers but in an appreciable reduction in their total number, while

[3] "In two specimens I have found an enlargement in certain suckers, and I do not think I am wrong in supposing that this is connected with hectocotylization. The largest and best preserved specimen exhibits after the sixth proximal sucker 4 or 5 broadened arm-suckers, of which the middle one is largest while the others decrease gradually in size. At the point of the arms 2 suckers are generally enlarged, sometimes abnormally so. Some of these enlarged suckers exhibit pathological alterations, being swollen and devoid of an aperture. The same condition is also found in a smaller specimen, not only 4 or 5 proximal suckers but also 2 or 3 distal ones having been enlarged."—Chun (1913, p. 21).

the cirri, except along the central portions of the arms, where they are quite large, seem less in evidence than in the female.

A beautifully preserved juvenile female [S. S. B. 1033] accompanied the described male. It is herewith illustrated (Figure 4), although the

FIGURE 4. *Opisthoteuthis californiana* Berry. Oral aspect of young female [1033]; nat. size.

dense blackness of its pigmentation was a source of some difficulty to the photographer. Measurements of both specimens are presented in Table 1.

The photographs accompanying this paper were made by Mr. Edgar R. Fisher of Redlands.

TABLE 1

Measurements of Opisthoteuthis californiana, in Millimeters

	♂ [1032]	♀ juv. [1033]
Length, total (axial spread to arm tips)	415+	185±
Width, total (estimated lateral spread)	435±	180±
Width of body at base of fins	90	33
Width of body back of fins	60	38
Width across fins	145±	60
Width across eyes	90	49
Length of body and head	80	52
Length of right dorsal arm (oral)	185+	88
Length of left dorsal arm (oral)	165+	88
Length of right second arm (oral)	185±	92
Length of left second arm (oral)	205±	95
Length of right third arm (oral)	210±	90
Length of left third arm (oral)	220±	90
Length of right ventral arm (oral)	220±	95
Length of left ventral arm (oral)	220±	88
Length of umbrella, dorso-median segment	120±	60
Length of umbrella, right dorso-lateral segment	135±	65
Length of umbrella, left dorso-lateral segment	75+	65
Length of umbrella, right lateral segment	115±	65
Length of umbrella, left lateral segment	120±	70
Length of umbrella, right ventro-lateral segment	95+	65
Length of umbrella, left ventro-lateral segment	130±	65
Length of umbrella, ventro-median segment	115±	65
Diameter 6th sucker from base, right dorsal arm	9	1.5
Diameter largest distal sucker, right dorsal arm	11	
Length of right fin	14	6
Length of left fin	17	10
Width of right fin	30	11
Width of left fin	30	16
Width of pallial aperture	40±	10
Length of funnel (median)	40	21
Length of free portion of funnel	26	14

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A COMPARISON OF FOUR DEER CENSUS METHODS[1]

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INTRODUCTION

During studies of Columbian black-tailed deer (*Odocoileus hemionus columbianus* Richardson) in the chaparral-covered mountains of Lake County, California, west of Lakeport, we have tried four methods of censusing deer. These are: the total deer count, the Lincoln index count, the sample-area count, and the pellet-group count. These census methods were used between 1949 and 1953 in an extensive study of an area of about 5,000 acres, and from 1951 to 1953 in an intensive study of a 400-acre area. It was from the intensive study that most of the findings reported below were obtained.

The 400-acre study area was covered, for the most part, by vegetation known as "opened-brush," in which a mixture of brush and annual herbs had been obtained by the use of fire and subsequent seeding of annual plants. Much of this area had burned in 1949, with the result that the sprouting brush was low in height, and visibility was improved. From selected vantage points the deer could be watched throughout the day. With careful study, many of the deer groups resident in the area could be recognized. To aid recognition, deer were trapped and ear-tagged so that they could be identified wherever they were seen. The presence of tagged or otherwise recognizable deer made possible the use of the Lincoln index census method.

The comparison of census methods depended for success on the limited mobility of the deer. It was found that deer in this region spend most of their time in a limited area, and that during a given counting period few, if any, move from one sample area to another. The results of the studies of deer mobility have, in part, been reported previously (Dasmann, 1953).

TOTAL DEER COUNT

Knowing the appearance of the resident deer groups, we could tally each month the total population of the study area. The population was considered to include those deer which spent most of their time inside the 400-acre area.

SAMPLE-AREA COUNT

A method for determining the deer population in sample areas was developed, along with a technique for making herd composition counts

[1] Submitted for publication April, 1955. Contribution from Federal Aid in Wildlife Restoration Project California W-31-R and the Museum of Vertebrate Zoology, University of California.
The senior author was a pre-doctoral fellow, National Science Foundation, 1952-53.

(Dasmann, R. F., and R. D. Taber, MS). This involved observing deer from vantage points from which a large expanse of deer range could be seen. From these lookout points with favorable weather, all of the deer visible were counted during morning and evening feeding periods. The total number of deer seen was related to the total area under observation, and a density figure was obtained. From several such counts of representative areas, an average population density for the study area was obtained. Unlike the total deer count, this method did not involve recognition of individual animals.

LINCOLN INDEX COUNT

The Lincoln index count was used starting in July, 1952, by which time there were enough marked deer in the study area to permit comparison between numbers of marked and unmarked deer observed. The average number of marked deer observed during a month's time was believed to bear the same relationship to the average number of all deer (marked or unmarked) seen during the same period as the total number of marked deer resident in the study area bore to the unknown total population of deer.

PELLET-GROUP COUNT

Within the 400-acre area, 50 circular plots, each 100 square feet in size, were located at random. Starting in October, 1951, these plots were cleared of all deer pellets. They were revisited in January, 1952; May, 1952; November, 1952; and March, 1953. On each visit the pellets were counted and removed. Thus, the pellet count for each period represented the number of groups deposited during a known number of days. From this the number of pellet-groups per acre was calculated and the figure converted into a population density figure for deer. Initially, the assumption was made that a deer deposited 13 pellet groups per day (Bennett, English, and McCain, 1940; Rasmussen and Doman, 1943; McCain, 1948; Biswell et al., 1952).

COMPARISON OF CENSUS RESULTS

The results of the various censuses are compared in Table 1. It may be noted that there is, in most cases, correspondence between the figures obtained by the Lincoln index, total deer count, and sample-area count. Some discrepancies can be explained. In October, 1951, the sample-area count records more deer than the total deer count. At this time, large numbers of bucks, ordinarily resident elsewhere, were visiting the study area as part of their rutting activity. These bucks were tallied during the sample-area counts, but not included in the total deer count because they were known not to be part of the resident population. The discrepancy in December, 1952, is probably an error in interpreting the average resident population in the total deer count.

The pellet-group census figures, based on an assumed defecation rate of 13 groups per day, agree approximately with the values obtained from other census methods, except for the period November, 1952, to March, 1953. This is a season when the diet of deer on opened-brush range consists of large amounts of fresh herbaceous forage. Longhurst (1954) has shown that when sheep are placed on green grass their rate

TABLE 1

Comparison of Census Results (Expressed in Deer per Square Mile)

Period	Census method			
	Total deer count	Lincoln index	Sample-area count	Pellet group count
July, 1951	131	--	130	--
October, 1951	96	--	113	--
December, 1951	88	--	86	--
Average, January-May, 1952	78	--	79*	79
July, 1952	112	113	112	--
August, 1952	109	105	113	--
Average, June-November, 1952	103	109†	100	93
December, 1952	99	70	78	--
Average, November, 1952 to March, 1953	94	86	83	120
March, 1953	80	83	73	--
May, 1953	69	69	68	--

* January, 1952, only.
† July-August, 1952, only.

of defecation increases from an average of 13.26 groups per animal per day to 15.50. Our findings indicate that the defecation rate for deer also increases. For the November to March period the rate must be about 17 groups per day if the pellet-group census is to agree with the results of the other census methods.

It seems unlikely that the defecation rate for deer is stabilized at 13 groups per day during most of the year, and 17 groups per day during the green-feed period. McCain's (1948) figure of 12.7 groups per day was obtained from Rasmussen and Doman's (1943) data for deer feeding on dormant browse on a winter range. It is probable that a different rate of defecation prevails when deer are feeding on newly sprouting browse in the spring. The population figures for our 400-acre area and those obtained during more extensive studies can most readily be explained if we assume that changes in the rate of pellet-group deposition took place as shown in Table 2.

TABLE 2

Changes in Deer Defecation Rate

Period	Principle forage in diet	Pellet-groups per deer day
April-June	Sprouting brush	10.0
July-October	Dormant brush	13.0
November-March	Green herbaceous feed	17.0

Such changes would explain not only the major discrepancy in Table 1, for the November-March period, but also the agreement in the January-May period, and the low figure obtained by the pellet census in the June-November period.

DISCUSSION

The most useful census method in the Lake County area is the sample-area count. This requires the least time and effort, and produces results which agree with most of our other observations. This method, however, has limited application elsewhere, requiring as it does relatively open areas of hill or mountain country and a sedentary deer population. Two other census methods were of equal accuracy, the total deer count, and the Lincoln index. However, neither of these has widespread usefulness, requiring either a prolonged study of a small area or a number of marked deer in the population.

The pellet-group census would have the widest application if its results could be relied upon. Our studies indicate that the defecation rate varies, and we can suggest values for the defecation rate which help eliminate discrepancies in our census figures. Such values, however, are only tentative. They require careful checking in future studies before they can be accepted without reservation.

SUMMARY

Deer populations in Lake County chaparral range were censused by the use of four techniques. Three of these, the sample-area count, total deer count, and Lincoln index, yielded population figures in close agreement. The fourth method, the pellet-group count, produced results which indicate that defecation rates for deer vary with the diet. Tentative defecation rates for different diets are presented.

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SEXING DAY-OLD RING-NECKED PHEASANT CHICKS BY A COLOR CHARACTERISTIC[1]

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A review of planting histories of the ring-neck pheasant (*Phasianus colchicus*) in California reveals that the State has planted over one million birds in 57 counties during the past 29 years. As a result, virtually all land suitable for pheasants now has established breeding populations. Studies by Harper et al. (1951) have shown that when a population becomes established stocking of additional birds for breeding purposes does not materially increase the supply of birds in the field. Departmental policy governing the stocking of game farm birds has shifted from planting for breeding stock to planting for hunting. It has been found that planting just prior to and during the season produces the most pheasants in the hunter's bag. In planting for the gun, it is desirable to plant cocks as opposed to hens. To this end it is necessary to sex pheasant chicks at hatching time.

The method of Latham (1942) for sexing day-old pheasant chicks has been in use previously. Latham used the shape and extent of the cheek patch or eye field as the sex indicator. Supplementing this method is a color characteristic observed at the Yountville Game Farm which appears in about one out of every four females. This characteristic, designated in Figure 1 by the letter D, is a positive sex indicator when present and increases the accuracy and speed of sexing. This dark-colored line or patch usually extends from the area around the ear to a point midway under the eye. Occasionally the dark line is broken and only one or more dark spots appear. However, whether continuous or in spots, this characteristic is always an indicator of female sex.

By using Latham's method supplemented by the newly observed color characteristic, accuracies of better than 90 percent have been accomplished at the Yountville Game Farm. Excess female chicks have been sold to private breeders or destroyed.

Examinations to determine the success of this method of sexing showed these results: of 2,368 12-week-old birds in sportsmen's pens, and of 9,225 breeders at State installations, 94 percent had been successfully classified as male birds, while of 2,577 breeders, 98.5 percent had been successfully classified as female birds. An examination of 2,545 mature birds sold as day-old female chicks indicated that 96 percent had been properly classified by this method.

The sexing of over 10,000 day-old chicks as males showed a success rate of 94 percent, while the sexing of more than 5,000 day-old chicks as females was even more successful, with percentages running from 96 to 98.5.

[1] Submitted for publication March, 1955.

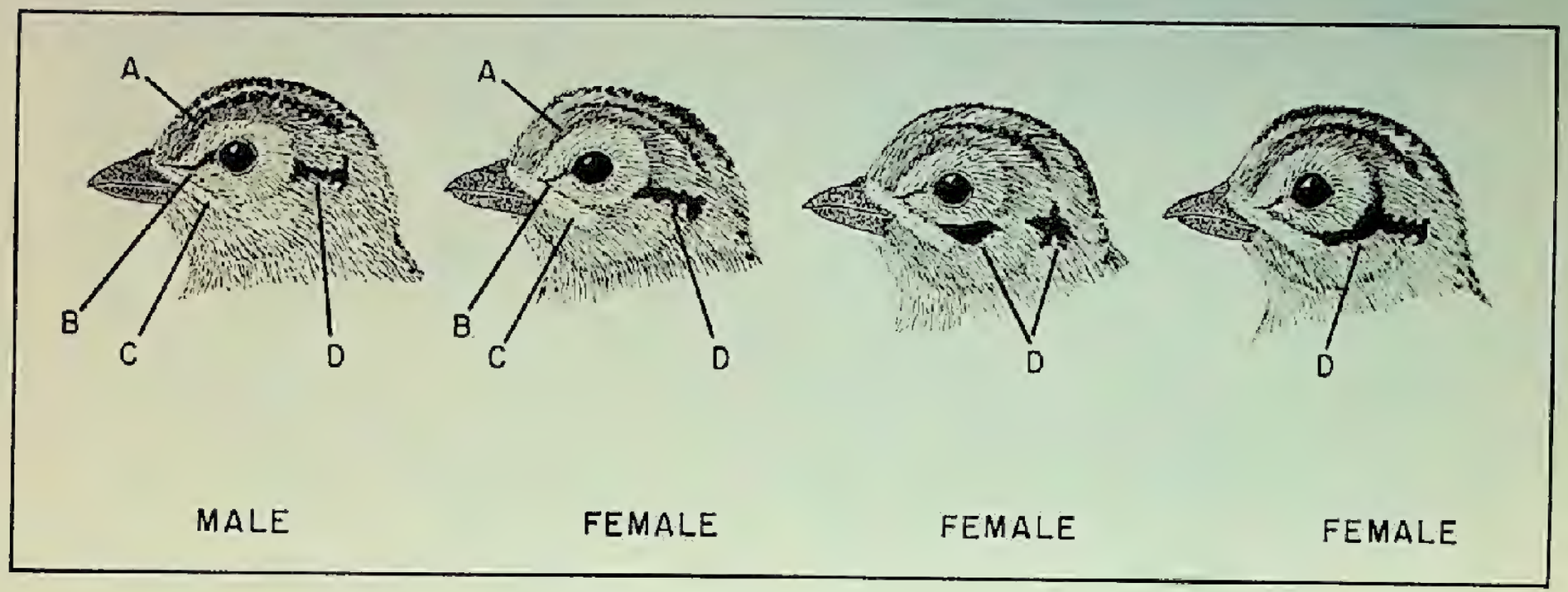

FIGURE 1. Characters used in sexing day-old pheasant chicks.

A. The abrupt angle of curvature in the upper fore part of the eye field indicates male sex; in comparison, even curvature is found in the female.
B. The angle and length of the line from the eye to the downy strip is longer and more angular in the male than in the female. This character is variable, however.
C. The width of the strip of long down tends to be narrow in the male and broad in the female. This character is extremely variable, however.
D. The extension of the dark strip along the lower edge of the eye field, whether continuous or broken, is an accurate indicator of female sex.

—Drawing by D. D. McLean

At the close of the 1954 regular incubation and hatching season, 550 day-old chicks were counted and separated 100 to a box, plus one box of 50. The total of 550 was used by six game farm employees in an experiment to test the speed of sexing day-old birds. The average time needed to sex 100 chicks was 8½ minutes, ranging from a minimum of seven minutes for three employees to a maximum of 13 minutes needed by one worker. One man needed 7½ minutes and a sixth took 8½ minutes. Thus, by using recognition of the shape and extent of the cheek patch and the color characteristic as a sexing method, day-old ring-necked pheasants were successfully sexed (94 percent or better) at a cost of less than one-half cent per bird.

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EXPERIMENTAL HATCHING OF KING SALMON IN MILL CREEK, A TRIBUTARY OF THE SACRAMENTO RIVER[1]

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INTRODUCTION

In the fall of 1952 survival studies on the eggs of king salmon (*Oncorhynchus tshawytscha*) were conducted on Mill Creek, Tehama County, California, a tributary of the Sacramento River. These were a part of a study investigating freshwater influences on survival rates of salmon near the southernmost limit of their spawning range. The reasons for widely fluctuating survival rates of salmon from year to year are being sought by fishery biologists in an effort to improve management techniques.

Grateful acknowledgement is extended to Robert Azevedo and James Miggens of the Branch of Game-Fish and Hatcheries, and to Don A. LaFaunce and Harry P. Chandler of the California Department of Fish and Game, for their assistance in conducting this experiment.

EXPERIMENTAL PLAN

Carl (1940), in an experiment involving silver salmon eggs buried in gravel in a hatchery trough, found that 8 percent of the eggs were unaccounted for following hatching. Since the design of the present experiment required that an accurate account be kept of a known number of salmon eggs in the gravel, any influence the containers enclosing the samples might have on survival had to be sacrificed.

The experimental plan called for 100 sample plants of 100 eggs each. An additional 10 sets of 100 unfertilized eggs were planted for comparison of their rate of decomposition with that of the test plants, and another five groups of fertilized eggs were planted as controls.

A long riffle adjacent to the old Mill Creek hatchery at Los Molinos, California, was selected for the study (Figure 1). The bottom was of large gravel cemented to the stream bed. Even though natural spawning occurred here each year the rubble found in the riffle did not appear to be entirely satisfactory for natural spawning and was supplemented with five cubic yards of three-fourths inch gravel.

Five rows of 23 nests each were used, making a total of 115 groups of eggs. The nests were spaced in rows one meter (39 inches) apart. Each row of five nests was marked with lengths of pipe driven into the banks. The nesting areas were prepared by removing gravel to form a pocket in the bed, 6 to 10 inches deep and about 18 inches in diameter.

[1] Submitted for publication August, 1954.

FIGURE 1. Riffle in Mill Creek, Tehama County, selected for egg planting, showing pipes marking rows of nests.

The eggs were placed in containers made of gray "Rust-proof Lumite Screening" of 19 meshes per inch and stitched into 5½- x 10-inch bags with orlon thread. A numbered tag was wired to the inside of each bag for identification and the mouth of each bag tied with a length of cotton cord which had a colored tag at the end. Cotton line was found to be inadequate for tying the bags because of its rapid deterioration. Nylon or similar material would be expected to serve much better.

Water temperatures and stream flows were found to be satisfactory for planting on October 29, 1952. On that day fish culturists of the Coleman Hatchery, using standard hatchery techniques, fertilized eggs from six female king salmon. A hundred eggs and about half a pint of gravel were placed in each plastic sack.

The filled sacks were transported to Mill Creek in five 10-gallon milk cans. The water temperature in Coleman Hatchery was 54 degrees F. Upon arrival at Mill Creek, a 40-mile trip which took approximately one hour, the temperature of the water in the milk cans had increased to 58 degrees F. At 1 p.m. the temperature of Mill Creek was 56 degrees F., and the air temperature was 65 degrees F.

The sacks of eggs were distributed at random among the prepared nesting areas in the stream bed. Each sack, marked by one of five different colored tags for identification, was placed in the previously hollowed-out spot and covered with gravel up to 2½ inches in diameter which, when necessary, was supplemented by the extra supply of three-fourths inch gravel that was available. The nests were covered from 6 to 10 inches deep. On October 29, 1952, 11 of the sacks were dislodged

by king salmon building nests in the stream. To avoid further losses of this type, the area was covered with wire netting.

RESULTS

The first group of 20 sacks removed from the stream on October 31st, two days after the initial plant, showed a 47.4 percent survival (Table 1). The high mortality of the first group after being in the gravel only two days was evidently due primarily to premature handling and transportation of the eggs. At least some of this mortality could have been avoided by a longer water hardening period. Many of the eggs apparently died upon coming in contact with the plastic screening of the containers.

TABLE 1

Comparison of Egg Conditions in Each Removal Group, With Average Eggs per Sack and Standard Deviations

Group	Removal date	Number of eggs found	Moldy and/or ruptured	Opaque	Clear unfertilized	Alive
1 (20 sacks)	10/31/52	1,985	0	10	*	948
Mean per sack		99.2	0	0.5		47.4
Standard deviation						8.4
2 (20 sacks)	11/11/52	1,771	856	16	54	845
Mean per sack		98.4	47.6	0.9	3.0	46.9
Standard deviation						11.1
3 (20 sacks)	11/24/52	1,403	694	16	24	669
Mean per sack		82.5	40.8	0.9	1.4	39.4
Standard deviation						11.7
4 (20 sacks)	12/14/52	817	365	108	65	279
Mean per sack		51.1	22.8	6.8	4.1	17.4
Standard deviation						7.1
5 (6 sacks)	2/26/53	263	256	0	7	0
Mean per sack		43.8	42.7	0.0	1.2	0.0
Standard deviation						0.0

* It was impossible to separate clear unfertilized from dead eggs at this stage.

Each of the remaining four groups of 20 sacks was removed at intervals of 238 heat units. Table 2 gives the number of heat units accumulated during the test.

Information on the number of heat units required to hatch king salmon eggs was obtained from staff members of the School of Fisheries at the University of Washington (Figure 2). The number of heat units is calculated by multiplying the number of days of incubation by the number of degrees Fahrenheit above freezing (32 degrees F.) (Wales, 1941). An expected average temperature of 50 degrees F. was used in estimating the number of heat units required to bring the eggs to each stage of development. The observed average temperature was 47 degrees F.

The second group was removed November 11, 1952. During the period that this group was in the gravel the stream flow remained relatively stable, with the temperature of the water cooling slightly as

TABLE 2

Accumulated Heat Units

Date	Daily number heat units	Subtotal upon removal date	Date	Daily number heat units	Subtotal upon removal date
Oct.			Dec.		
29	22.7		1	13.0	
30	22.9		2	14.0	
			3	12.8	
31	20.8	45.6	4	12.8	
Nov.			5	13.6	
1	20.8		6	13.4	
2	19.4		7	13.4	
3	20.7		8	14.5	
4	18.6		9	15.1	
5	18.9		10	15.8	
6	20.6		11	17.0	
7	20.8		12	16.8	
8	20.0				
9	19.2		13	15.4	711.5
10	19.3		14	15.0	
			15	14.7	
11	19.9	264.7	16	14.0	
12	20.5		17	14.0	
13	20.2		18	14.0	
14	19.1		19	14.5	
15	16.6		20	14.9	
16	14.9		21	13.5	
17	13.8		22	13.8	
18	13.7		23	13.4	
19	14.2		24	12.8	
20	14.8		25	12.5	
21	14.8		26	14.0	
22	13.6		27	14.4	
23	11.4		28	14.8	
			29	15.2	
24	10.0	472.2	30	16.0	
25	10.0		31	14.5	
26	9.6		Jan.		
27	9.6		1	14.6	
28	9.2				
29	9.0		Total	——	997.5
30	9.7				

winter progressed. Examination of the second group indicated a survival of 46.9 percent or 98.9 percent of the Group 1 rate. A theoretical loss of 1.1 percent had occurred between October 31st and November 11th.

On November 24th the third group of eggs was removed, after 472 heat units. During the period since the previous removal, the stream flow remained stable but the temperature declined from a daily mean of 52 degrees F. to a mean of 42 degrees F. The third group showed a survival rate of 40.5 percent or 85.4 percent of the Group 1 rate. A theoretical 14.6 percent mortality had occurred from October 31st to November 24th.

On December 13th, the fourth group was removed, after 712 heat units. Since the previous removal, the Sacramento Valley had experienced severe storms which caused Mill Creek to flood. In certain parts of the experimental stream section boulders and gravel were piled 18 to 24 inches deep, while in other portions the stream bed was scoured bare by erosion. Information obtained from the California

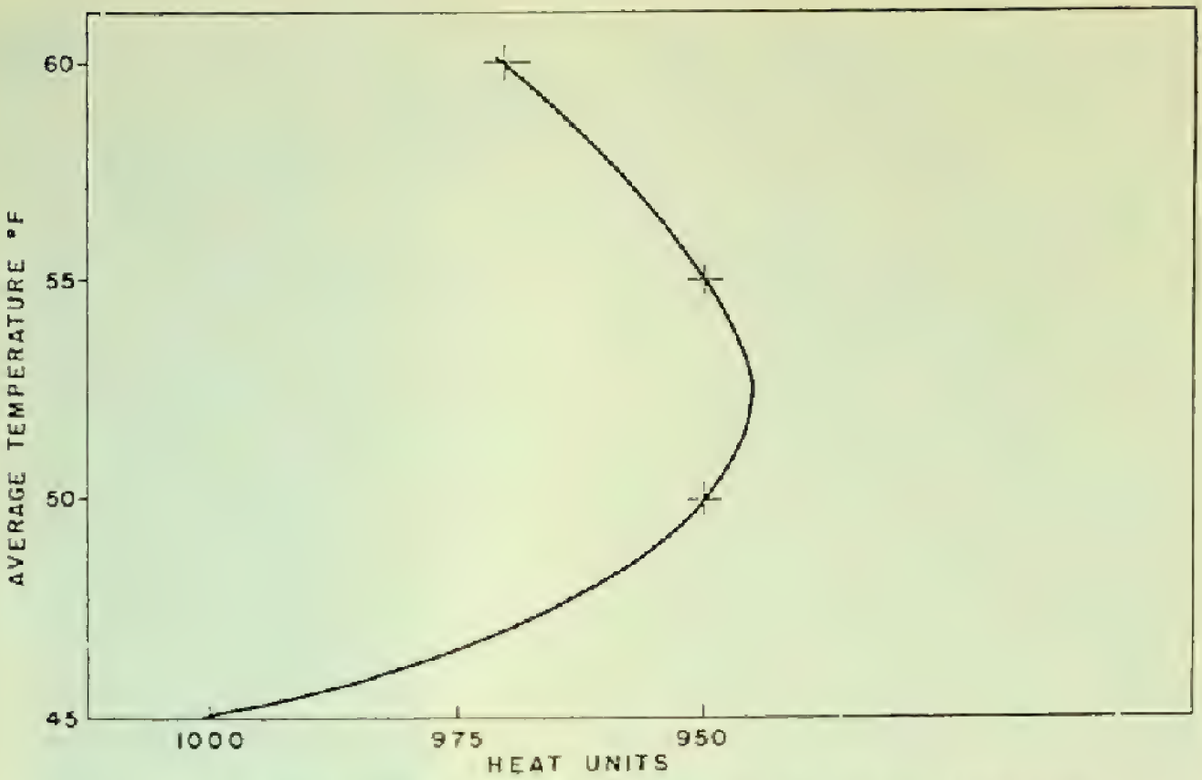

FIGURE 2. The estimated number of heat units required to hatch king salmon eggs at various temperatures.

State Division of Water Resources indicates that the stream flow increased on December 7th to 1,250 c.f.s. at a point 100 yards downstream from the planting site, which was an increase of 25 times the rate of flow recorded at the time the eggs were buried.

This high water caused a high loss to the eggs remaining in the stream bed. Only 17.4 percent of Group 4 survived, or 36.7 percent of the Group 1 rate. A loss of 63.3 percent had occurred since October 31st. Temperatures began at 41 degrees F. and rose during the period of the storms, remaining at approximately 47 degrees F. the remainder of the time Group 4 was in the stream.

A sufficient number of heat units had accumulated by the first part of January to permit removal of the fifth group of eggs. However, high water conditions prevailed (Figure 3), and the investigators were not able to work in the stream until the end of February.

The upper Sacramento River system continued to flood during the last stage of the experiment. The water gauge used by the California State Division of Water Resources was torn from its position by the flood. Records received from the Water Resources Branch of the United States Geological Survey show the flow of Mill Creek rose to 5,240 c.f.s., or approximately 100 times the flow recorded at the time the eggs were planted. The result was that all but six sacks of eggs disappeared from the stream bed. Examination of the sacks that could be found revealed that none of the embryos had survived the floods. The shifting of the channel and the eroding and smothering action of silt and sand apparently caused a complete kill of the developing young salmon.

Damage by silting and erosion has been reported by biologists previously. Allen (1951) describes the vulnerability of alevin to freshets. Davidson and Hutchinson (1943) observed pink salmon destruction

FIGURE 3. Stream flow at flood stage January 13, 1953, when the flow was approximately 1,500 c.f.s.

from floods in Alaska. Neave (1947) reported loss of chum salmon eggs by silting and suffocation in Nile Creek, British Columbia. Shapovalov and Berrian (1940) ran a silver salmon egg incubation experiment in hatchery troughs filled with gravel in which a loss of 89.8 percent resulted from silting.

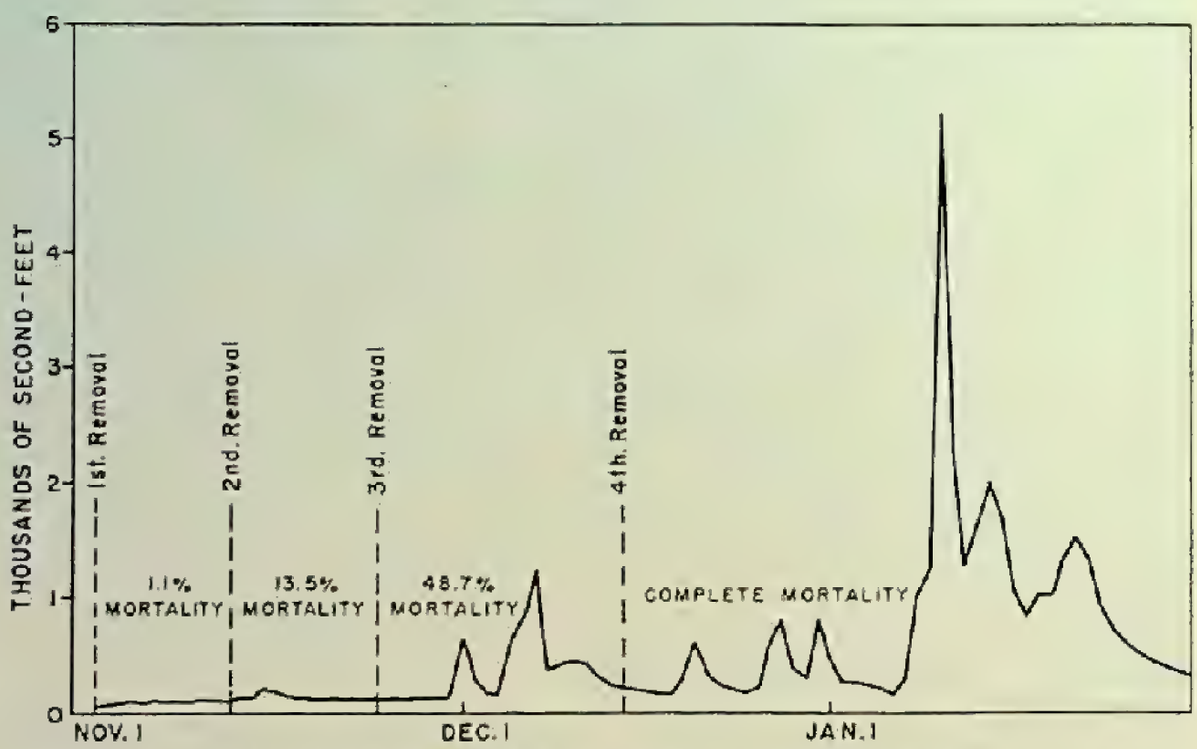

FIGURE 4. The fluctuations in stream flow of Mill Creek and the percentages of mortality of egg samples during the winter of 1952-1953.

Figures 4 and 5 show the stream flows and temperatures during the experiment. Sudden runoffs like the ones experienced in 1952 not only damage spawn in the gravel, but are likely to deprive future spawning salmon of proper spawning gravel. The unstable runoff pattern may well be the reason that only 1.79 percent of the Mill Creek stream bed was reported as suitable for spawning by Hanson, Smith, and Needham (1940).

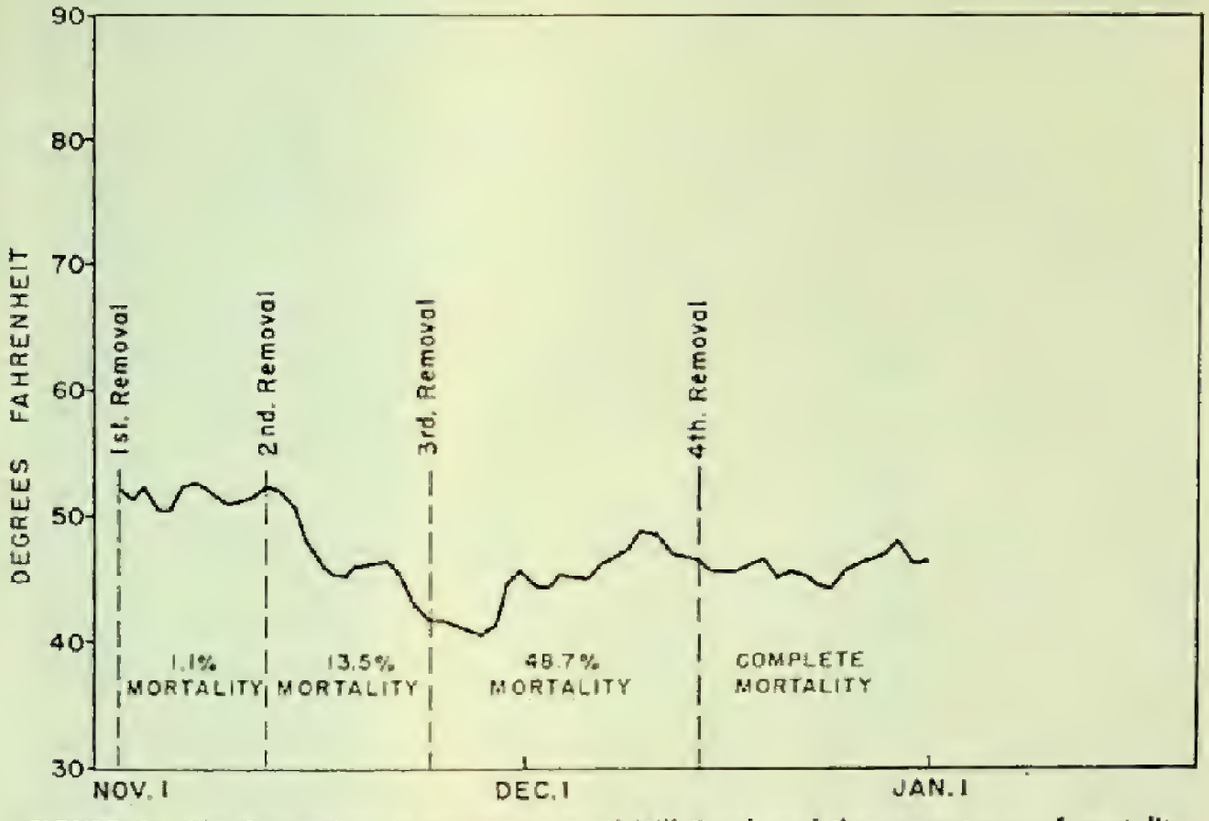

FIGURE 5. The fluctuations in temperatures of Mill Creek and the percentages of mortality of egg samples during the winter of 1952-53.

Influences of Position on Survival

The possibility that position in the stream might have significant influence on the rate of survival was considered. Within the 7- by 23-meter area selected for the experiment, a variation in velocity and in the direction of current existed. The greatest variation occurred between the fringe areas and the center of the stream.

The variation in survival was first reduced to a common denominator. This amounted to determining the average egg survival in each group and expressing the survival of each sack as a percentage of its removal group's average. It follows that any sack with better than average survival will be represented by a figure in excess of 100 percent.

The ratio of survivors in each sack compared to each group average was plotted in its relative position in the stream (Figure 6). It appeared that no group of eggs had any particular advantage over any others from the standpoint of position in the stream.

The variance of egg survival rates of each column was tested against all the other columns for each removal group. In addition to this, an

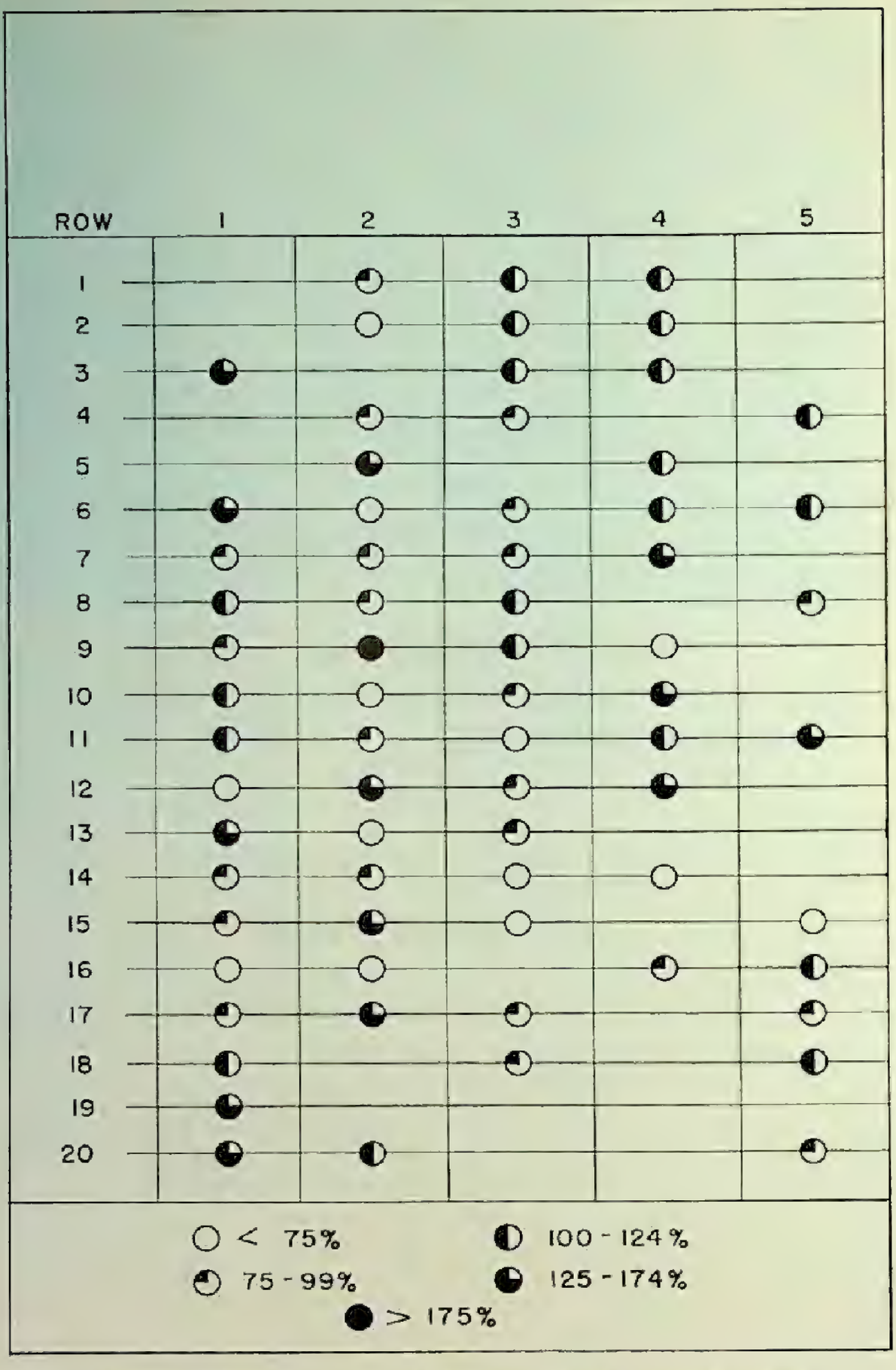

FIGURE 6. Relative survival based on group averages of samples of eggs planted in gravel nests in Mill Creek.

analysis variance within the columns was made. No difference existed in survival rates among or within the columns of any group at the 5 percent level of significance.

No significant difference at the 5 percent level was found among the mean survival rates of the groups removed from the gravel on October 31st, November 11th, and November 24th. However, the mean survival rate of the group that was removed on December 13th was found to be significantly less than the means of the first three groups. The group removed on February 26th was not included in the analysis because of insufficient data for that group.

SUMMARY

One hundred sacks of eggs of king salmon (*Oncorhynchus tshawytscha*) were planted in the stream bed of Mill Creek, a tributary of the Sacramento River, California, in 1952. The sacks were removed 20 at a time at intervals during the period up to hatching stage to determine when mortalities occurred. In addition, temperatures and stream flows were recorded and other pertinent information was noted, to determine the cause of the mortalities.

Water flow was stable during the period when the first three groups of eggs were in the stream. The survival rates of these groups were not significantly different.

Between the times of the third and fourth removals, stream flow reached a maximum of 1,250 c.f.s. The average egg survival in the fourth group was less than half the survival of the third group. The increased mortality was attributed to erosion and silting.

High water conditions during January and February delayed removal of the last group of eggs. When the stream subsided, less than one-third of this group of sacks was found. Complete mortality had occurred during this period when the water flows had exceeded 5,000 c.f.s.

The influence of position on the survival of eggs was tested and found to be not significant.

Water temperatures remained well within the critical limits for salmon eggs during the entire course of the experiment.

Although the information available from this experiment is not conclusive, it does suggest a direct relationship between floods and mortalities of king salmon eggs.

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NOTES

HYDROSTATIC PRESSURE TESTS ON RAINBOW TROUT

The tests described were designed to determine the ability of trout to withstand the pressure conditions that occur in penstock and turbine chambers of a hydroelectric system, and were carried out as a part of the Pacific Gas and Electric Company's Cooperative Fish Study with the California Department of Fish and Game. The testing apparatus was designed by William O. Cheney of the Pacific Gas and Electric Company and fabricated at the company's Bureau of Tests in Emeryville, California. The pressure tests were carried out at Crystal Lake Hatchery, Shasta County, on May 7, 1953, by Mr. Cheney and the writer, who at the time was employed by the California Department of Fish and Game.

The apparatus, shown in Figure 1, consisted of a lucite tube five inches in diameter and about 18 inches long, two grooved end plates, four restraining through-bolts, and a pump and gage connected to one end plate by means of a flexible metallic tube.

Rainbow trout (*Salmo gairdneri*) approximately eight inches in average length were taken directly from the hatchery rearing ponds and subjected to pressures from 50 to 200 pounds per square inch, after which they were placed in separate troughs for observation.

Three trout were used in each test. Air bubbles were removed from the vessel and the pressure was increased with the hand pump at a rate approximately corresponding to that which would occur in a penstock. The pressure release was virtually instantaneous, as in a turbine. The pressure and times of exposure are shown in the following table.

Pressure (lb./in.²)	*Time (seconds)*
50	6
50	12
100	12
100	24
150	18
150	36
200	24
200	48

The fish were immobilized while under pressure, but resumed normal activity immediately after pressure release. A single trout caught against the release valve was the only casualty. All others used in the tests showed no detrimental effects during a two-week observation period.

It appears that, barring mechanical injury from contact with the turbine or penstock, rainbow trout of this size can survive the pressure

FIGURE 1. Pressure apparatus used in tests.

and release effects experienced in hydroelectric systems in which conditions similar to those of this experiment are produced.—*William E. Rowley, Jr., University of California, Berkeley, January, 1955.*

THE USE OF VITAL STAINS IN MARKING PACIFIC COAST STARFISH

The predation of starfish on commercially important shellfish is well known. The starfish, *Pisaster ochraceus*, a common rocky shore form along the Pacific Coast, is a voracious feeder, but is not at present a problem in California waters. However, it is a pest on some British Columbia oyster beds, though normally not a serious one (Quayle, 1954). Since a more complete understanding of its life history would be helpful in any future control program, an extended investigation of this starfish has been conducted. Two types of marking techniques have been used in the course of the study and are discussed here.

Petersen plastic disk tags attached by stainless steel wire, used extensively in tagging fish, were first tried. The method was relatively successful, and a large number of tagged specimens were observed in the field for three to five months. However, it was soon obvious that the insertion of the wire through the tissues at the base of an arm often resulted in injury to or actual loss of the tagged arm. Since normal animals are essential to a natural history study, vital stains, which do not ordinarily injure the living animal, were next tried as a marking method.

Loosanoff (1937) used the vital dye Nile Blue Sulfate in marking the Atlantic Coast starfishes *Asterias forbesi* and *A. vulgaris*. These animals, normally orange-red in color, stained a very deep blue. Loosanoff's method consisted of submerging either the entire animal or a portion of it for a few minutes in a continually aerated solution of the dye. The solution was prepared by dissolving one gram of the dye in a small volume of distilled or tap water and adding sufficient sea water to make one liter.

This technique has been successfully applied in the present study. Although the dye used by Loosanoff, Dr. G. Gruebler and Company's Nile Blue Sulfate, is no longer available, the same type dye manufactured by Hartman Leddon Company has proved to be an effective substitute. Nile Blue Sulfate produced by the National Aniline Division is not soluble in sea water and could not be used.

Although most specimens of *P. ochraceus* in Monterey Bay are dark in color, the white spines on the upper surface stain blue and retain this stain for two to three months. Recognition, though still easy during the fourth and fifth months, necessitates an examination of the lower surface of the animals in order to find the blue color. The stain starts to fade rapidly during the sixth month, but some starfish collected seven months after staining still showed a trace of blue on some of the spines.

Vernon (1937), working on the Atlantic Coast, has used Neutral Red in the study of *Asterias*. This vital stain, manufactured by the National Aniline Division, has also been successfully used in our marking experiments. The staining solution is prepared in the same way as noted above, except that three to four grams of the dye are used per liter of solution. The animals are immersed in this solution until they have a deep red color orally—usually 5 to 10 minutes. As with Nile Blue, the solution should be aerated while the animal is being stained. Marked animals generally retain the stain for about five months, but

occasional individuals have retained some red coloration for as long as 10 months.

The utilization of these two vital stains has made it possible to mark *P. ochraceus* without mechanical injury to them. Since the starfish has its madreporite eccentrically situated, the arms can be differentially stained in various combinations, using this morphological feature as a reference point. In addition, both dyes can be used on the same animal, greatly increasing the number of possible combinations.

Valuable information on growth and movement has been obtained through use of this marking technique. Individual starfish have been examined for as long as 14 months by simply restaining them periodically. The effects of this technique apparently are not harmful, since some of the stained starfish increased their weight by as much as 30 percent in four months.

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—Howard M. Feder, Hopkins Marine Station of Stanford University, Pacific Grove, California, February, 1955.

RESIGNATION

WILLIAM A. DILL

William A. Dill, Senior Fisheries Biologist in charge of the Dingell-Johnson federal aid to fisheries program, resigned from the California Department of Fish and Game on April 15, 1955, to accept appointment as head of all freshwater fisheries biological work for the United Nations Food and Agriculture Organization. His headquarters will be in Rome, Italy.

A graduate of Stanford University, Mr. Dill taught biology and fisheries at the University of Santa Clara for a six-year period before joining the staff of the California Department (then Division) of Fish and Game in 1937.

Although Dill's initial work had centered around oceanography and marine fisheries, his more than 17 years of service with the Department were devoted largely to freshwater fisheries research and management. In 1951 he organized and to the time of his resignation administered with outstanding success the federal aid to fisheries program for both inland and marine fisheries in California. He also served several years on the editorial staff of *California Fish and Game* as Editor for Inland Fisheries. Some 75 formal administrative reports on a wide variety of subjects prepared during this period, as well as his published writings, are a partial measure of the extensive contribution which he made to the field of his work and to the organization with which he was associated. His co-workers and the sportsmen of California will feel his absence deeply. They wish him well in his new and important endeavor.

In Rome Mr. Dill's mailing address will be: Fisheries Division, Biology Branch, Food and Agriculture Organization of the United Nations, Viale delle Terme di Caracalla, Rome, Italy.—*Leo Shapovalov, Editor.*

IN MEMORIAM

HARRY PHYLANDER CHANDLER

Harry P. Chandler died on April 16, 1955, after an illness of more than a year. At the time of his death Mr. Chandler was employed as Assistant Fisheries Biologist with the Trout Management Study of the Inland Fisheries Branch.

Harry was of sturdy Mormon stock. Graduated from Brigham Young University in 1939, he continued on to get a Master of Arts degree in entomology from the same institution in 1941. In the fall of 1941 he entered the graduate school of the University of California at Berkeley. His studies there were interrupted by four years of naval service, during which he attained the rank of Lieutenant, J. G., and served as gunnery and torpedo officer on a destroyer in the North and South Pacific. Upon release from the service he again entered the University of California, where he continued his work in entomology, leaving in 1947 to join the Department (then Division) of Fish and Game.

By training and by aptitude, Harry was one of the most proficient biologists the Inland Fisheries Branch has ever had. His particular ability was aquatic entomology and he soon became a national authority in this field. In 1946-47 he worked at the University of California on a research fellowship collecting and classifying aquatic insects. He assisted Dr. R. L. Usinger of the Entomology Department in writing a syllabus for the first course on the Biology of Aquatic and Littoral Insects to be given by that department and later taught the laboratory portion of the course. Among other scientific publications by Chandler are descriptions of a new genus and five new species of aquatic insects. Several important scientific works were left unfinished when death cut short this promising career at the age of 37 years.

His many friends and colleagues extend their most sincere sympathy to his wife, LaJune Chandler, four children, mother, and sister.—*Joseph H. Wales, Inland Fisheries Branch, California Department of Fish and Game.*

REVIEWS

Favorite Flies and Their Histories

By Mary Orvis Marbury; Charles T. Branford Company, Boston, reissued 1955; viii + 522 p.; illus. $15.

"Favorite Flies" was first published by Houghton-Mifflin 63 years ago. The book consisted mainly of letters from fishermen concerning their experiences with artificial flies and theories concerning their use. These had been written by anglers from 38 states in response to inquiries by Charles F. Orvis, Vermont fly tyer and tackle-maker.

The letters were gathered together by Orvis' daughter, Mary Marbury, who arranged them geographically and interspersed them with her own comments. She also compiled notes on 291 trout, salmon, and bass flies, which were illustrated in color. The notes ranged from brief descriptions to page after page of quotations on the joys and sorrows of angling.

I am not sure just how many editions there were of this book. Certainly, it has been out of print for many years and has been considered a collector's item, known to have commanded a price as high as $45. The new edition by the Branford Company is limited to 2,000 copies. I suspect it is very close to the original in format and printing. The illustrations, 32 plates in six colors, were made from new plates in Holland; the name of the artist is not given. Incidentally, the Orvis Company of Manchester, Vermont, still has the original set of fishing flies from which the plates were reproduced.

There is just one plate showing what were then called the new "Halford's floating flies". All of the others are of wet flies, and most of these are pictured with snells or gut loops. The text is just as dated. But read it, if you will, as a pleasant reminder of a gentler and more innocent age. Greenheart and lancewood were still used for rods. *Salmo fontinalis* was king. And an angler could write, unabashedly, of letting his flies drop upon the water, "Softer than petals from blown roses on the grass".

Only a few of the respondents' names are familiar today. Dr. Charles Henshall of black bass fame is one. Among the Californians is Ramon Wilson, Secretary of the State Board of Fish Commissioners in 1891-1892.

Sixty-three years is a long time, and many of the flies mentioned are unknown to the fisherman of today. However, in one of Charles Zibeon Southard's books there is a list of the most popular American flies based upon the frequency with which they are mentioned in Mary Marbury's book. And, as attested to by the anglers of the Nineties, the most popular then were: the Coachman, Professor, Royal Coachman, Black Gnat, and Brown Hackle. I guess neither fishermen nor fish have changed very much after all. Each of these can still be listed among the favorite flies.—*William A. Dill, California Department of Fish and Game.*

Spinning in America

By Ray Ovington; The Stackpole Company, Harrisburg, Pa., 1954; 205 p., 66 figs. $5.

This book, by a fly rod purist who succumbed to curiosity and to the dulcet tones of a tackle salesman, makes a serious attempt to carry spin fishing from the booming, bawdy side of the tracks towards respectability.

If spinning is a controversy in your life, I suggest you read this book. Mr. Ovington's wide experience with all types of fishing tackle well qualifies him to write this treatise on spin fishing.

Crammed into 205 pages is almost everything from the history of spin fishing through a philosophical thought on what makes a fisherman. Tackle, methods, fresh- and saltwater fish, and the pursuit of them with spinning gear are all covered. Pacific Coast salmon, steelhead, and saltwater anglers will regret that most of the

text is devoted to the Eastern area of the country. However, if there happens to be a shad stream near your home, the section on shad fishing should give you ideas.

It is extremely unfortunate that the pictures illustrating the preparation of a spinning reel for casting are placed so far from the instructions in the text—101 pages to be exact—and that the pictures are given in reverse order. The novice might find it somewhat difficult to translate the instructions for casting into practice.—*Clarence S. Kabel, California Department of Fish and Game.*

Principles of General Ecology

By Angus M. Woodbury; The Blakiston Company, Inc., New York, 1954; vii + 503 p., 167 figs. $6.

As stated by the author, this recent addition to texts on ecology is "* * * designed as a college text of general ecology at upper-division level * * * organized to fit a semester course * * * assumes a foundation knowledge of general biology, general botany, and general zoology.

"The work is an attempt to outline those fundamental principles which are so necessary in understanding the relationships between organisms and their environment."

The text has been organized under two subdivisions: the physical environment and the biotic environment. "It seemed to the author that this arrangement is not only more fundamental but is also preferable to other methods of subdivision on such basis as aut- and syn- ecology, chor- and chron- ology, re- and co- action, inter- and intra- specific relations and others."

Students can be prepared for some difficulty in understanding Dr. Woodbury's word usage. "In the preparation of this work it has been difficult to extract, from special fields, words or terms with biotic meanings. Often it has been necessary to transform terms from special fields to broaden their meanings for use in the larger field * * *

"The work is based upon concepts derived from naturalistic processes. It is difficult, however, to portray accurately to others the ideas intended by the writer [Certainly this is the obligation of any writer to his reader]. If anyone reads into the work implications of anthropomorphism, Lamarckianism, or other unnatural implications, he will be placing interpretations on words not intended by the author. The author has a duty to his readers to make ideas clear and precise but the reader has a duty to the author to search for the author's meanings and not misconstrue his intentions." What a strange request made from a book which proposes to introduce the reader to principles of general ecology!

The first 46 pages are devoted to Introduction, Historical Perspective, and Organisms and Environment. The second section, The Physical Environment, has a total of 105 pages devoted to Soils, Water, Air and Its Constituents, Radiant Energy, Gravity and Periodicities, Climate, and Adaptations That Meet the Physical Environment. The third and largest section, Biotic Interrelationships, contains 252 pages, with the following major divisions: Biotic Communities, Development of Biotic Communities, Community Analysis, Conditions of Existence, Food Relations, Reproduction and Species Persistence, Population Problems, Dispersal and Evolution, Biotic Rhythms and Migrations, Biotic Adaptations, Historical Distribution, Geographic Distribution, Consortism, Social Relations, Societies, Ecology, and Human Affairs.

In his first three chapters the author briefly introduces the student to much of the terminology which has been used during the recent development of this discipline. Fortunately, he has dropped much of the abstruse terminology of Weaver and Clements. In so doing he has aided in reducing the obstacles of questionable wordage.

His chapter on historical perspective is brief; however, it demonstrates rather well the synthesis of fields of natural history in the development of ecology.

The first two sections contain an abundance of information on many aspects of natural history which would be of value to individuals lacking background for the serious pursuit of ecology.

For the most part the diagrams, illustrations, and tables are clear and to the point. Occasionally some of the material is elementary, and as such is not in keeping with the idea that the book is for use in "general ecology at the upper division level."

Infrequent studies and very few books purport to approach the study of ecology from the standpoint of the ecosystem and succeed in so doing. According to the

author, "This approach is used by some geographers and is the one utilized in this work." Desirable as this objective may be, the approach is not realized.

The chapter on Population Problems mentions only the very early statistical approaches. The author does not mention some of the outstanding work which has been done on quantitative population analysis. The relatively new and extremely important tool, statistical analysis, deserves more extensive consideration.

His concluding chapter, Ecology and Human Affairs, is appropriately chosen with regard to both position in the book and relevance to time. Necessity for development of an ecological conscience is implied. Inasmuch as popular references are frequently noted, it is odd that two of the most popular books on ecology as related to human affairs published in 1948 are not included: "Our Plundered Planet" by Fairfield Osborn, and "Road to Survival" by William Vogt. Instances were noted in which the older, rather than the newer, edition of a work was given: Hesse, Allee and Schmidt, 1937, is better in the second edition released in 1951, and the 1952 revision of "Limnology" by Paul Welsh should have been given. Reference to W. S. Cooper, 1926, "The Fundamentals of Vegetational Change", was improperly cited.

There is a wealth of suggested material in the bibliography, and any student wishing to go beyond the immediate material of the book will find adequate and interesting material for study. The student upon completing the study of the Principles of General Ecology will not have a very clear understanding of the principles, but should have a wealth of ecological information.—*Robert L. Butler, California Department of Fish and Game.*

Elements of Ecology

By George L. Clarke; John Wiley and Sons, Inc., New York, 1954; xiv + 534 p., 193 text figs. $7.50.

All of the currently accepted major groups (phyla) of animals have representatives that live their entire lives in a marine habitat. Plant life is also well represented in the sea. It seems only logical, therefore, that many examples of the intricate associations of animals and plants should be drawn from the lives of those species which dwell in the sea. To present these descriptions, the author, George L. Clarke, is perhaps as well qualified as any living person in the United States. Dr. Clarke took part as a biologist in the maiden voyage of the research vessel ATLANTIS in 1931 and has since participated in many scientific expeditions. He is now an Associate Professor of Zoology at Harvard, as well as Marine Biologist at the Woods Hole Oceanographic Institution and a consultant to the U. S. Fish and Wildlife Service.

The interrelations between organisms and their environment are very well treated in this volume. Hundreds of clear and concise descriptions of natural situations assist the reader to better understand the basic principles of ecology. After the reader familiarizes himself with the general viewpoint of modern ecology, various factors of the physical environment such as water, temperature, and light are treated individually. Following this, data concerning the intricate complexities associated with living communities are made to drop smoothly into place.

The 13 chapters are entitled: Viewpoint of Modern Ecology, The Medium, The Substratum, Water, Temperature, Light, Oxygen and Carbon Dioxide, Nutrients, Relations Within the Species, Relations Between Species, The Community, Succession and Fluctuation, and Dynamics of the Ecosystem. The more than 440 references used to document the well-chosen examples of various natural situations are for the most part drawn from up-to-date works—some published as recently as 1954.

It is unfortunate that such a well-written and easy reading volume should be so poorly indexed. In many instances it is impossible to locate in the index page references to words and phrases important enough to be italicized in the text. Many of the scientific names used in various examples throughout the volume are also missing in the index.

Regardless of this, "Elements of Ecology" should prove quite valuable as a standard text or reference at both high school and college level. In addition, it would be worth the purchasing price for every practicing biologist or zoologist to own, and thus have available for occasional perusal, this basic volume on ecology.—*John E. Fitch, California Department of Fish and Game.*

The Natural Regulation of Animal Numbers

By David Lack; Oxford University Press, New York, 1954; viii + 343 p., 1 col. drawing and 52 text figs. $5.60.

Generalizations in the natural sciences are few indeed, but work with the particular has in view the construction of principles. At intervals a synthesis is presented, then judged, accepted, or rejected, but the investigation continues. Here, then, is a synthesis concerned with *The Natural Regulation of Animal Numbers*. The title is stimulating and suggests, if not promises, a new understanding of living things. Most effort is expended understanding animal population in growth, but this book deals with mortality and the end of growth, or rather the containment of population growth.

The author is an ornithologist and as a consequence draws a conclusion or provides an analysis based on abundant observations in that field. However, he points to examples in other fields which sometimes destroy the opportunity for a generalization for all animals. Much of the text is concerned with birds, but after treatment of the problem in birds, the author turns to mammals, fish, and insects. Several principles which concern natural regulation of bird numbers are developed, but in the conclusion the author summarizes his principles for the natural regulation of animal numbers or rather the author's synthesis, for he draws upon material extending over 17 years of investigation. Readers of this journal will recognize the work of Leopold (deer), Glading (quail), and naturally many others, for there are over a thousand bibliographic references.

Doctor Lack does not treat the population problem mathematically, for he says, "In the early stages of a science a way has to be steered between two opposite dangers, on the one hand of theoretical ideas so simplified that they have no value in application, and on the other hand of facts so disorganized that no coherent theme is apparent. The first danger is greatest when the ideas have been expressed mathematically, as has happened in population research. The naturalist feels intuitively that there may be a catch somewhere, but is not qualified to discuss equations." This is a curious phenomenon—the mathematician entering the field of biology—but surely precise observation and organized thinking will be the benefit. The author is correct, however, for the biological sciences are the most complex that man has yet attacked and are not yet ready for mathematical generalization. Dr. Lack quotes Udny Yule, a statistician, "Logic and Mathematics are only of service, then, once you have found the right track; and to find the right track you must exercise faculties quite other than the logical—Observation, and Fancy and Imagination: accurate observation, riotous fancy, and detailed and precise imagination."

Physics is a science rich in mathematical generalization; it could not exist without it. We understand much of it, we have put it to work; but, as Beveridge has said, it is a simple science and so it is natural that man has made such progress in it. It is possible man will never understand the living sciences to the same degree. The foundation generalization in the living sciences was published in 1859, a rather late start. At present it is fashionable to explain the natural sciences mathematically. Statistics may serve us well but they can deceive us thoroughly.

Doctor Lack's principles, perhaps limited to the field of ornithology, include: bird population analysis, the phenomenon of reproductive rate, the age of birds, mortality factors limiting bird numbers, bird cycles, irruptions, and dispersions. In these categories he claims original analysis. Original or not, his logic—from particular to principle—leaves no alternative; certainly, the reviewer feels the author is a practical man. If the reader feels all solutions are obvious, the reviewer understands this to be a tribute to good writing and clear thinking.

Three factors control animal populations: food shortage, predation, and disease. It is clear the author believes food shortage the most important of the three. All may act in combination, although he traces many examples to the ultimate factor, food shortage. Food shortage is a condition, as are the others, of animal densities, barring, of course, the occasional emergency. The reproductive rate is a product of natural selection and many animals are unable to exercise their physiological potential; nonetheless, reproductive rate is no factor in the control of animal numbers. As Darwin wrote, "Even slow-breeding man has doubled in 25 years, and at this rate in less than a thousand years, there would literally not be standing-room for his progeny." Therefore, it is food shortage, disease, and predation which prevent animals from increasing to unlimited numbers. In the conclusion the author makes a clarifying statement, often observed in the field of fishery biology: "If an animal is introduced to a new and favorable area it at first increases rapidly, but it is soon checked, and thereafter its numbers like those of other animals, fluctuate between

limits that are extremely restricted compared with what is theoretically possible. It follows that natural populations are in some way regulated, and that the controlling factors act more severely when numbers are high than when they are low. Except in a few cyclic species, the fluctuations are irregular, suggesting that the control is complex." One may infer from the last sentence that the control mechanism of cyclic populations is therefore not complex. Regular wide fluctuations must be controlled by a few factors or one. Essentially, Dr. Lack says that the limited work in the field indicates that a cycle is a predator-prey oscillation (therefore, a food-determined oscillation) and the regularity of the cycle is caused by this basic predator-prey oscillation, which is little disturbed by other factors.

This book may well become an important scientific document; certainly, workers in the field of animal populations will be handicapped if they neglect it.—*Robert R. Bell, California Department of Fish and Game.*

Stray Feathers From a Bird Man's Desk

By Austin L. Rand; Doubleday and Company, Inc., Garden City, N. Y., 1955; 212 p., 60 line drawings. $3.75.

A book of 60 short chapters that touch on an equal number of obscure but interesting facts of birds' lives. Each chapter is independent of the next, but continuity is complete within each topic. The main advantage of this treatment is that the book can be picked up at any time and enjoyed as much as if it were never put down. As a matter of fact, if the reader's time is limited, it is best to leave the book alone, because he is sure to overstay the allotted time. How can a reader break off his reading when absorbed in the topic of "Cormorant Fishing", which not only describes the fairly well-known facts about this type of fishing, but also includes an absorbing account of the methods used to train the birds.

The following chapter, "The Shrikes Larder", is only two fascinating pages; so read that too, there is surely time. And "Bird Flavors"—who could have guessed that the crested lark would be an epicurean delight, and who couldn't have predicted, from the name alone, that the white-rumped black chat would be at the bottom of the list?

A book of this type, documented and accurate to the detail, is a reference and also a delightful book all in one. The variety of subjects will make it a pleasure to read and re-read many times. Humorous line drawings by Ruth Johnson preface each chapter.—*Parke H. Young, California Department of Fish and Game.*

The Composition of Scientific Words

By Roland Wilbur Brown; published by the author, U. S. National Museum, Washington, D. C., 1954; 882 pages. $8.

"The Composition of Scientific Words" is a revised and greatly enlarged version of the author's "Materials for Word-study", published in 1927. In its present form the book contains a three-page foreword, one page of abbreviations and symbols, an introductory chapter of 55 pages, a cross-reference lexicon of 815 pages, two pages of bibliography, and a two-page index.

In the words of the author, the intent of the book is to "promote skill and pleasure in composing words, and thus, although not intended to be a panacea for all the ills of nomenclature, may, by offsetting some of the bad effects resulting from decreased instruction in classical languages, diminish the area and amount of verbicultural wrongdoing."

The introduction contains an extremely interesting section on the history and nature of the English language. There are also sections on the nature of Greek and Latin, formation of scientific terms, gender, and spelling and pronunciation. To read and properly assimilate even a major portion of the sage advice and general information contained in these introductory paragraphs would mean many days of studious concentration. Only persistent, systematic study, practice and critical appraisal will produce the desired facility and expertness in the art of composing scientific words.

The "lexicon" is arranged on the cross-reference plan, the English key-words receiving their appropriate Latin, Greek, and other synonyms, with derivative examples. The etymologies of the entry-words are given, as are the genders of nouns and those of the more unusual adjectives by their nominative singular terminations. The perfect participle, but not always the present participle, of a Latin verb is given.

To the reviewer's knowledge there has never been published a book of comparable nature which has included such a wealth of information. A work such as this has been long needed and much desired by taxonomists the world over. Its usage need not, however, be limited to those individuals specializing in descriptions of new plant and animal forms, but should encompass students of Greek or Latin, plus generally word-conscious persons, regardless of literary or scientific learnings.—*John E. Fitch, California Department of Fish and Game.*

Timber in Your Life

By Arthur H. Carhart; J. B. Lippincott Company, Philadelphia, 1955; 317 p. $4.

This new book by Carhart has been reviewed with great interest because of the problems which we are encountering in California due to the effects of logging of previously untouched streams. There is no question that our fisheries resources, particularly in the north coastal streams of California, are being jeopardized in the manner Mr. Carhart describes. This book is particularly valuable because it is one of the first to discuss the technical aspects of forest conservation primarily in terms of what it means to the general public rather than the specialist. The result is a factual and easy-to-read report, although the effort to popularize the subject tends to overemphasize the more sensational or spectacular phases of the problem. Mr. Carhart, wisely in my opinion, avoids the pitfalls of presenting broad philosophical solutions to all the problems of timber management, but instead confines himself to a discussion of the technical and political problems which must be solved, and current management techniques.

The book covers a field considerably broader than the title suggests, since Mr. Carhart goes into other phases of water conservation in terms of their ultimate effects on our economy. Unfortunately, the scope of the book is so wide that many aspects of the problem receive rather cursory treatment and it seems that a rather inordinate number of personal reminiscences have been included, somewhat at the expense of other significant problems, such as necessity of utilizing wood that is presently wasted in the logging operations and the adjustment of our tax structure to encourage private owners to hold their forests until sustained yield cutting is made more feasible.

This book is notable for being up-to-date. Many of the incidents mentioned, such as the interesting discussion of the Aiken-Hope grazing legislation of 1954, point out the speed with which the author has written the book. Mr. Carhart is an almost unique combination: he is a good writer of popular articles, possesses a technical background as a landscape architect with the Forest Service, and has enjoyed careers both as a city planner and with the Pittman-Robertson program of the Colorado Fish and Game Commission.

This book is highly recommended as being particularly timely for California because we are just coming up against many of the logging problems which have caused conflicts in other areas of the country. California is probably the only state which has the opportunity to consider the effects of logging while many of our important watersheds are still untouched. It is essential that the problems outlined by Carhart be resolved on the north coastal streams of California in the near future if the water and wildlife resources of this region are to be preserved.—*R. M. Paul, California Department of Fish and Game.*

Why Not Survive?

By Michael W. Strauss; Simon and Schuster, New York, 1955; xi + 272 p.; illus. $4.

Mr. Strauss has written an extremely interesting book with the general theme "We have in America the natural resources we need to survive with a constantly improved standard of living—if we are willing to use them wisely."-The author's training in journalism is used to excellent advantage and the result is an extremely well-written, lively book that reflects Mr. Strauss' "twenty years continuing course in conservation education."

The basic premise that we have plenty of resources for the future is in rather sharp contrast to other outwardly similar books that have been written in the past few years and the book can be highly recommended for its approach to the problem. Any reader who expects that Mr. Strauss' philosophy of governmental development might have changed since leaving the Department of Interior will be disappointed, and it would probably have been too much to expect that the author could still be anything but slightly resentful of the interests that were so critical of his efforts as Commissioner of Reclamation.

The book begins with a discussion of populations and resources and stresses the need for developing a program that puts these two factors on a comparable basis. Mr. Strauss then discusses in a very lucid style the various types and amounts of energy available to sustain our economy and our current status insofar as minerals, agriculture, and fisheries are concerned. It is notable that enough historical and topical references are included to avoid ending up with a series of significant but dull statistics.

In some phases of the discussions Mr. Strauss appears to be somewhat over-optimistic, and this is particularly true of his forecasts of the growth potential of the fishing industry. Unfortunately, he overlooks the technological and marketing problems that must be solved, to say nothing of the research needed to develop the management techniques necessary to insure that these resources are used wisely. Mr. Strauss notes the problems of fluctuating sardine abundance but still concludes "there are always more fish in the sea," which to some will be considered the zenith of optimism. There can be no question, however, about his basic argument that the marine fisheries resources are capable of supplying more than their present share of 3 percent of the world's diet and the problem, as with all other renewable resources, is to resolve the social and political conflicts.

Mr. Strauss' discussion of recreation and wildlife is unfortunately rather condensed. His apparent conclusion is that the future of wildlife is very dim in the face of economic development and that the recreation now derived from fishing and hunting will be shifted to other types of recreational activity as these resources decline in abundance. It was of interest to note that Mr. Strauss' evaluations are expressed in dollars and cents, rather than the intangible values that are now probably the most important insofar as the recreational phases of fish and wildlife are concerned, but he recognizes that in the long run there may be small logic in the political decisions that will ultimately have to be made in those conflicts such as the one now taking place over the Echo Park Dam in Dinosaur National Monument.

Mr. Strauss has given considerable thought to this book and made excellent use of the references which are available in this field, particularly the President's Material Policy Commission Report, which recently made an estimate of the country's needs in 1975.

Many technicians, particularly in the wildlife field, will no doubt argue with certain statements and many sportsmen will no doubt question the relegation of wildlife to the status of an interesting phenomenon which should be preserved in the manner of the buffalo, but on the whole this is a highly recommended book that should be widely read by all persons interested in the broad aspects of conservation.—*R. M. Paul, California Department of Fish and Game.*

Conservation Law and Administration

By William F. Schultz, Jr.; the Ronald Press Co., New York, 1953; xxv + 607 p. $10.

This "case history of law and resource use in Pennsylvania" is a long, detailed, and extensively documented volume. It contains a vast amount of information, evaluates strengths and weaknesses, and offers proposals for future courses of action. The author is professor of law at the University of Pittsburgh; he, with the assistance of many persons, prepared this report under the sponsorship of the Conservation Foundation and of the university's school of law.

The result is a book of considerable interest to those concerned with the administration of renewable natural resources or with the general problems of conservation and recreation. While the text treats one state, Pennsylvania, the underlying principles are not limited by geography.

Specifically, the topics discussed are game, fish, water, forests, soil, recreation, and conservation education. The latter two chapters are particularly commended to the general reader. In the final chapter the author delineates "a model act for conservation administration".—*Phil M. Roedel, California Department of Fish and Game.*

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